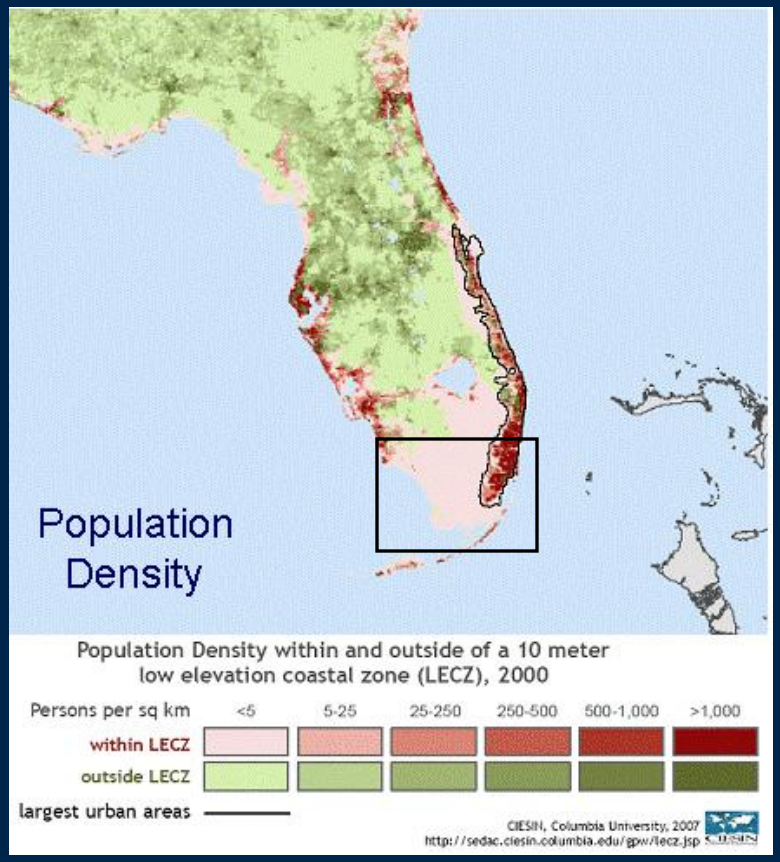

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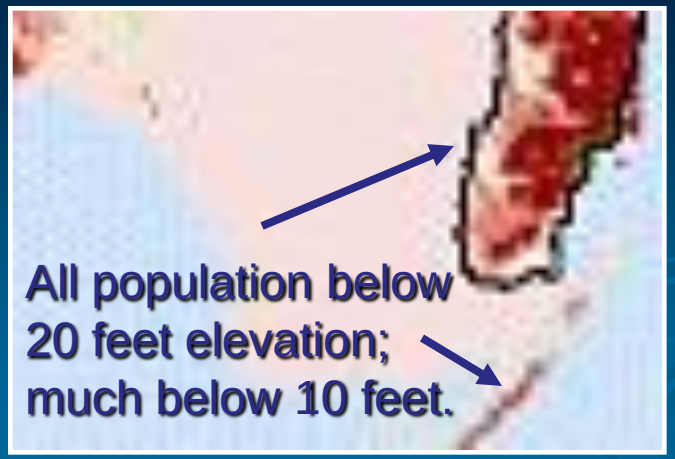


STATEMENT ON SEA LEVEL IN THE COMING CENTURY

SCIENCE COMMITTEE

MIAMI-DADE COUNTY CLIMATE CHANGE
ADVISORY TASK FORCE to the
BOARD OF COUNTY COMMISSIONERS

Presented by
Dr. Harold R. Wanless
Department of Geological Sciences
University of Miami

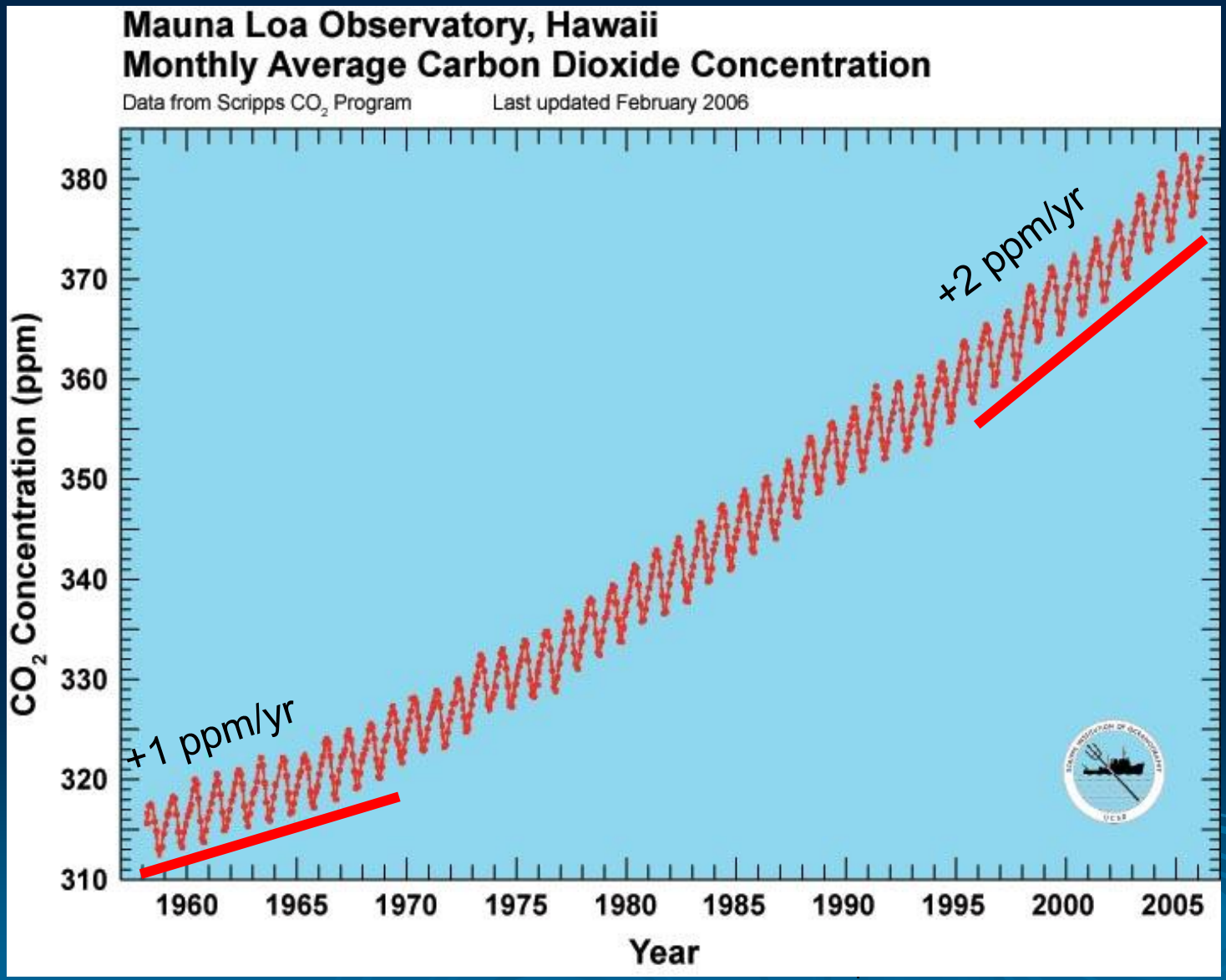
April 22, 2008

HUMAN-INDUCED GLOBAL WARMING IS REAL.

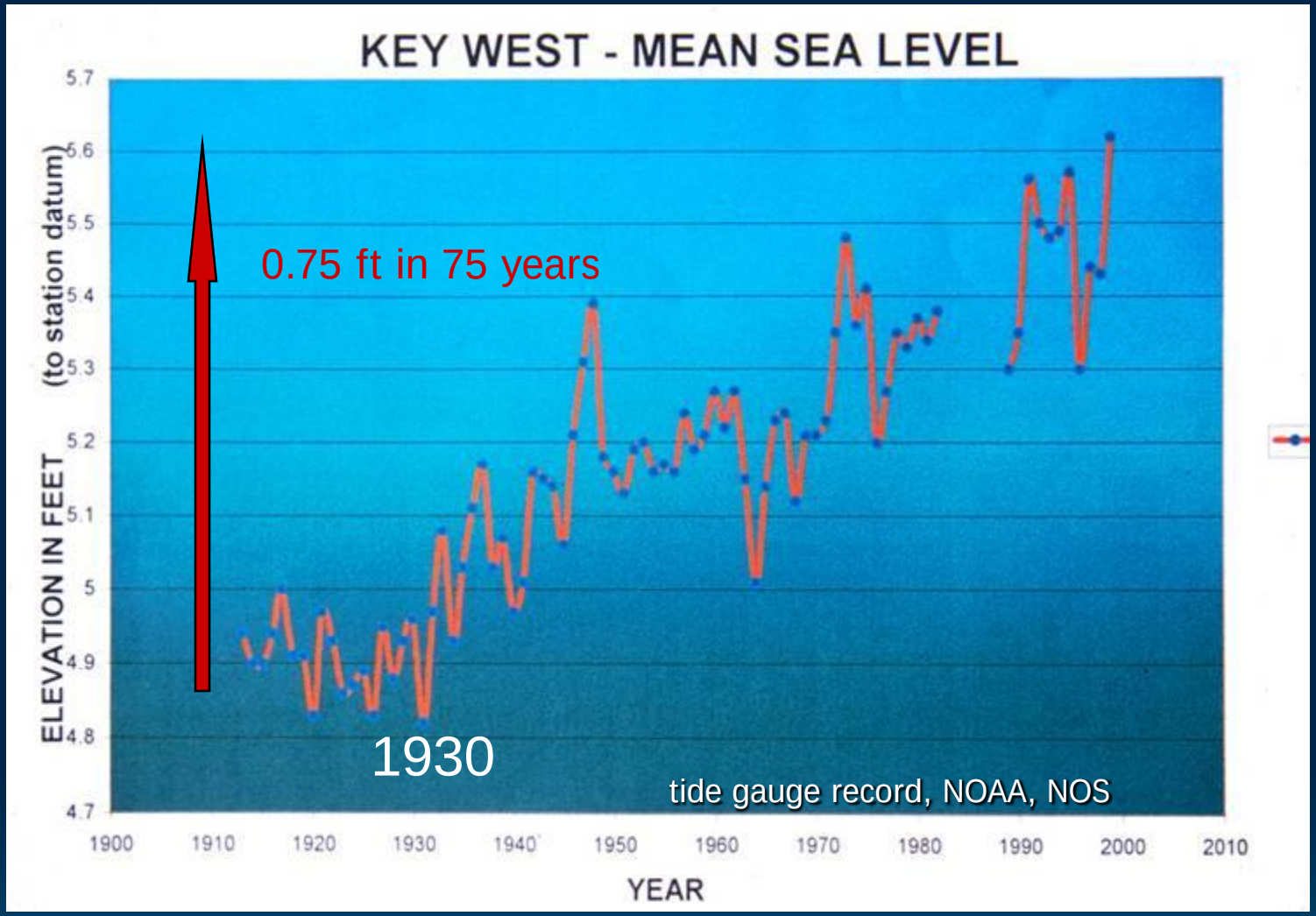
It has already started.

During the coming century, it will change Florida and Earth beyond your wildest imaginations.

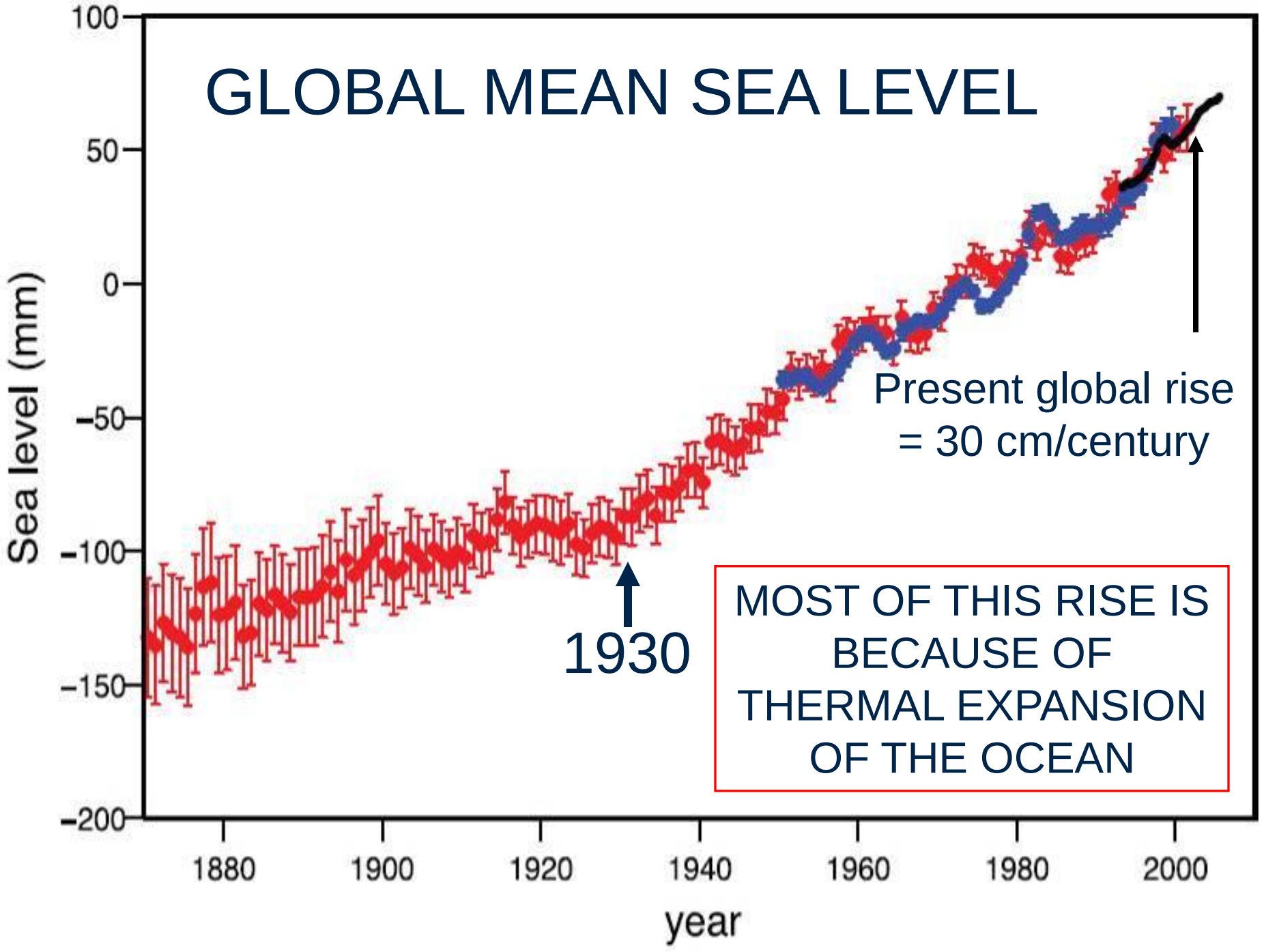
CO2 is increasing at an increasing rate,



and so are methane and the other greenhouse gasses.



Beginning in 1930, the rate of relative sea level rise increased about 8 fold over that of the past 2,000 years. It is presently rising at 30 cm (1′) / 100 years!

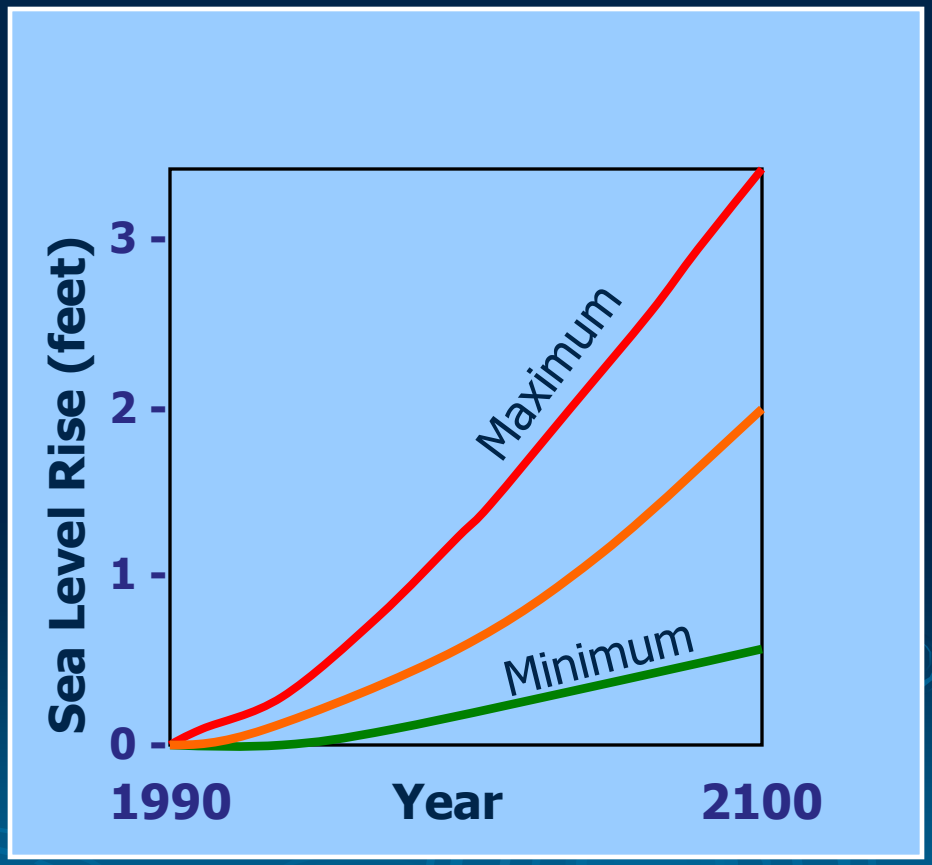

GLOBAL MEAN SEA LEVEL
Sea level (mm)
100
50
0
−50
−100
−150
−200
1880
1900
1920
1940
1960
1980
2000
year
1930
Present global rise
= 30 cm/century
MOST OF THIS RISE IS
BECAUSE OF
THERMAL EXPANSION
OF THE OCEAN

Climate and Sea Level Do Not Respond Gradually to stresses

- When stressed and destabilized, climate, polar ice and sea level will, at some point, reach a tipping point and undergo rapid change towards a new state.
- IPCC and other climate and sea level forecasts assume gradual linear responses and changes - not sudden tipping points, switches to new states, rapidly reinforcing feedbacks, and rapid rises.
- This is what has scientists studying climate, the Arctic and sea level close to panicked about the future.

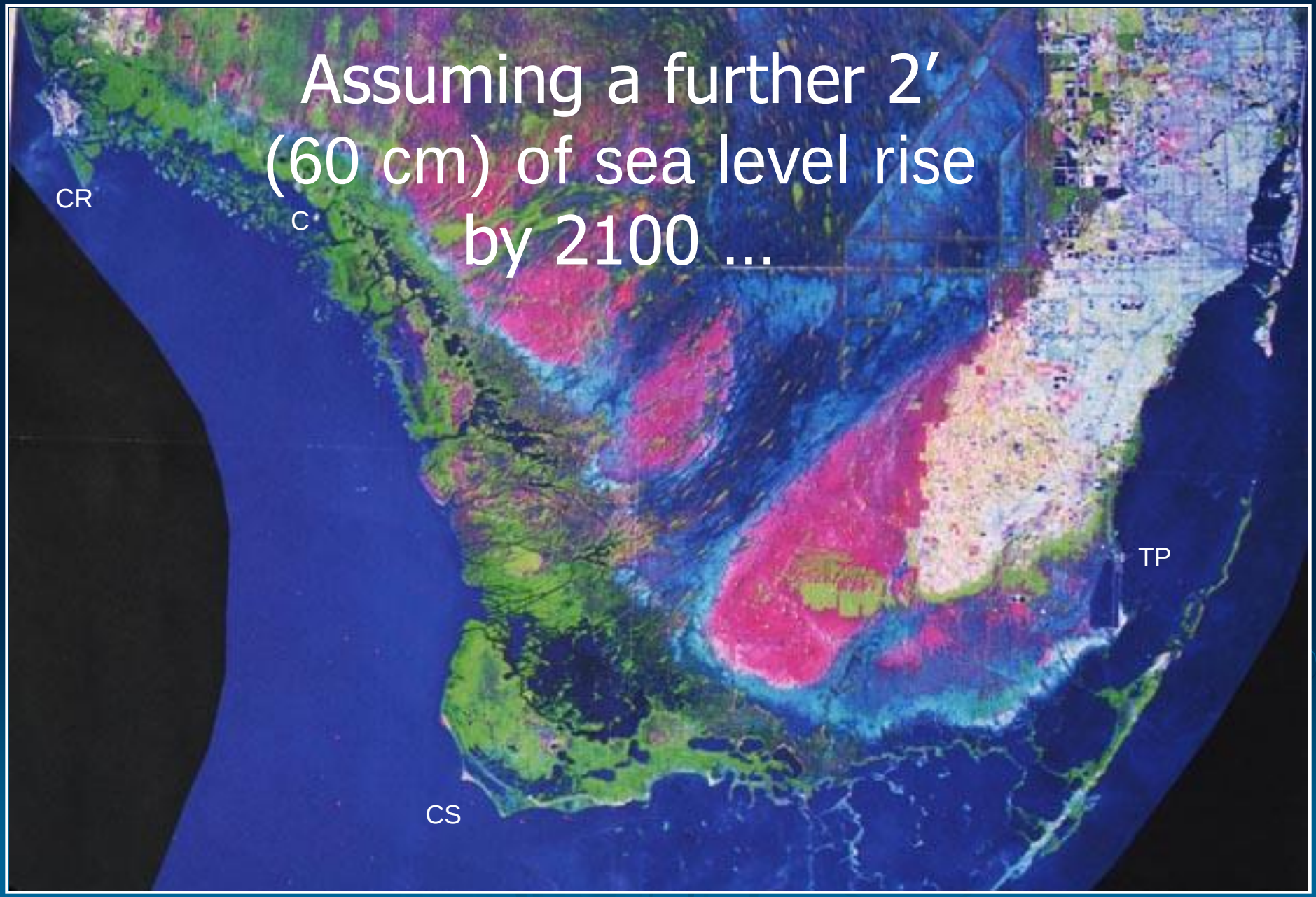
What is forecast for the future?

- Because of global warming, the 2001 UN Intergovernmental Panel on Climate Change forecasted a 2-foot further rise of sea level by 2100.
- These projections assumed a gradual linear response of climate and sea level.

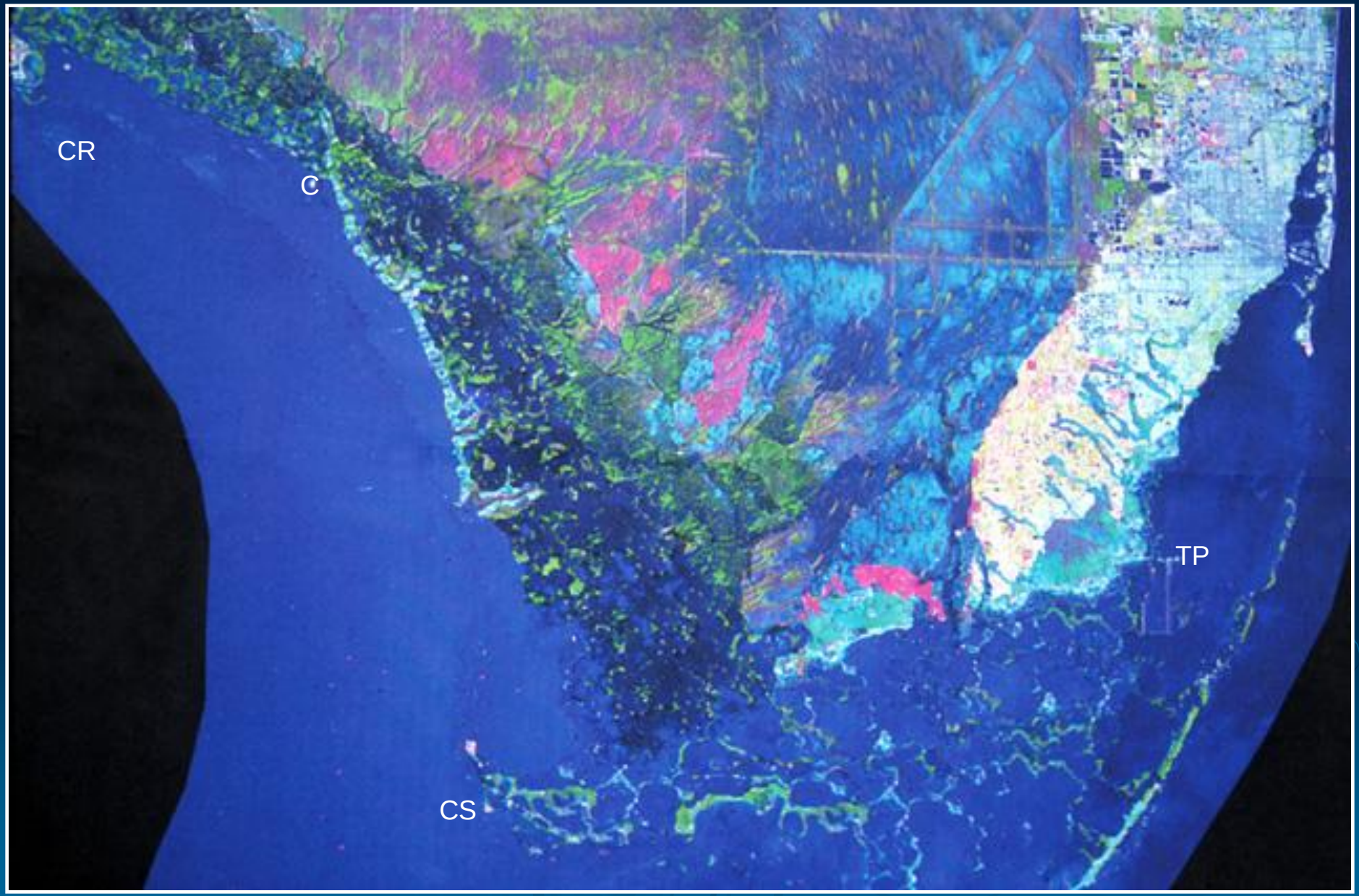


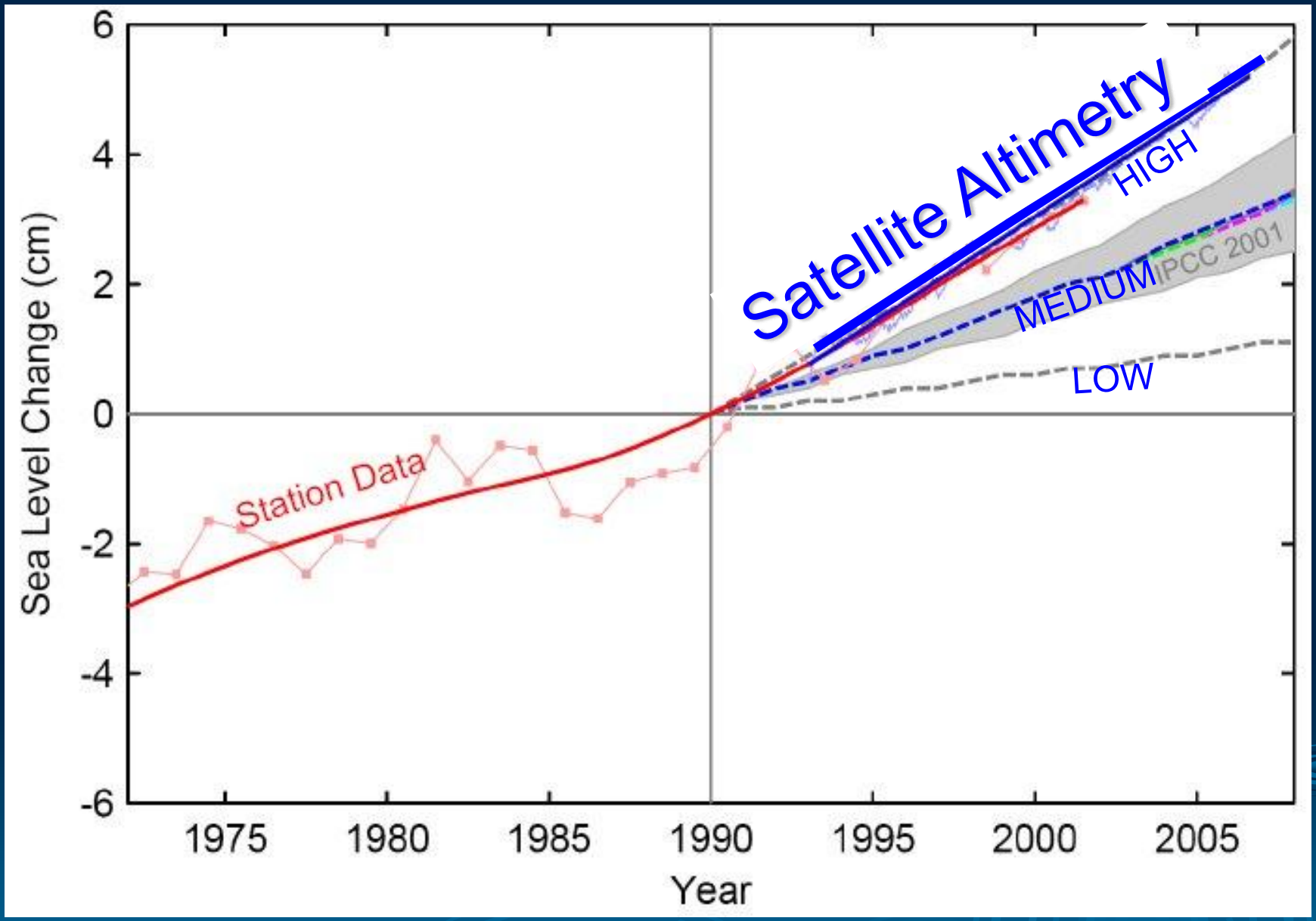
IPCC, 2001

South Florida 1995



+2 foot rise (mhhw = +4.5’ above 1929 MSL) **South Florida 2100**





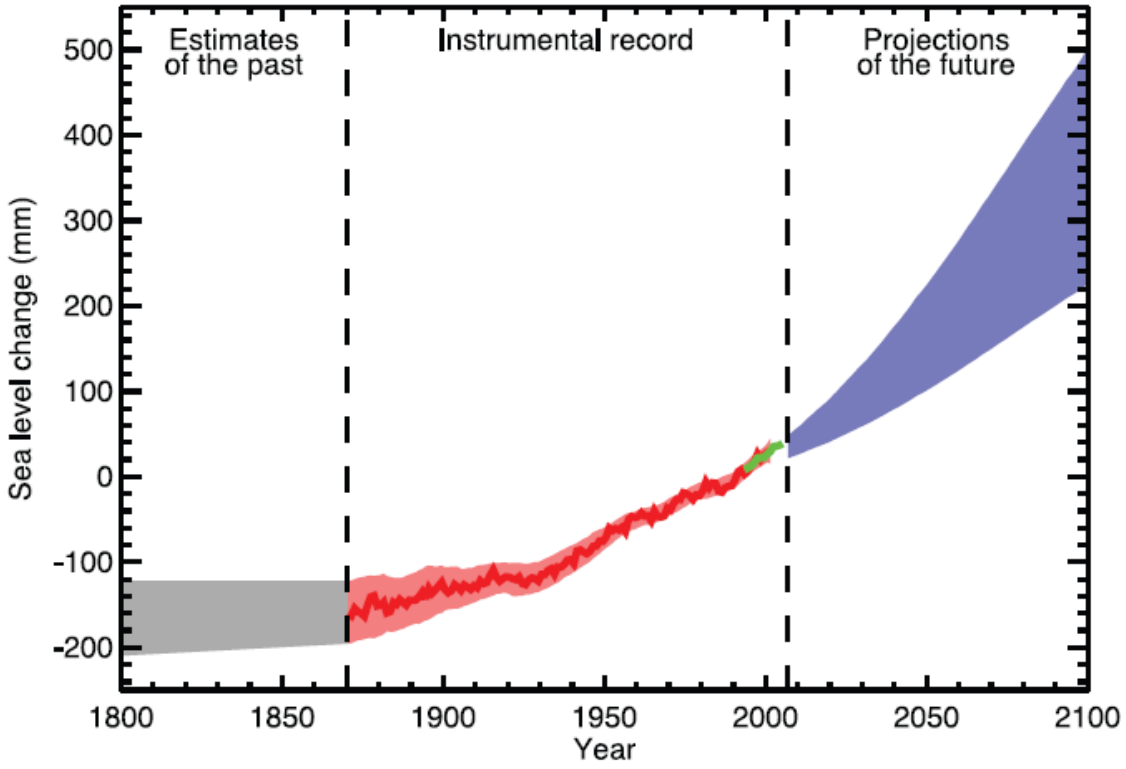
Global sea level rise (based on tide gauge and satellite data) has been following the highest end of the 2001 IPCC sea level projection.

Intergovernmental Panel on Climate Change
Historical Influences on
Global Sea Level Rise

Source	Global Sea Level Rise (mm yr–1) 1961–1992		1993–2003	
Thermal Expansion	0.03	± 0.12	**1.6**	**± 0.5**
Glaciers and Ice Caps	0.43	± 0.18	0.77	± 0.22
Greenland Ice Sheet	0.003	± 0.12	0.21	± 0.07
Antarctic Ice Sheet	0.12	± 0.41	0.21	± 0.35
Other	0.83	± 0.7	0.3	± 1.0
Observed	**1.8**	**± 0.5**	**3.1**	**± 0.7**

Calculated from IPCC, 2007

IPCC 2007 Projection



FAQ 5.1, Figure 1. *Time series of global mean sea level (deviation from the 1980-1999 mean) in the past and as projected for the future. For the period before 1870, global measurements of sea level are not available. The grey shading shows the uncertainty in the estimated long-term rate of sea level change (Section 6.4.3). The red line is a reconstruction of global mean sea level from tide gauges (Section 5.5.2.1), and the red shading denotes the range of variations from a smooth curve. The green line shows global mean sea level observed from satellite altimetry. The blue shading represents the range of model projections for the SRES A1B scenario for the 21st century, relative to the 1980 to 1999 mean, and has been calculated independently from the observations. Beyond 2100, the projections are increasingly dependent on the emissions scenario (see Chapter 10 for a discussion of sea level rise projections for other scenarios considered in this report). Over many centuries or millennia, sea level could rise by several metres (Section 10.7.4).*

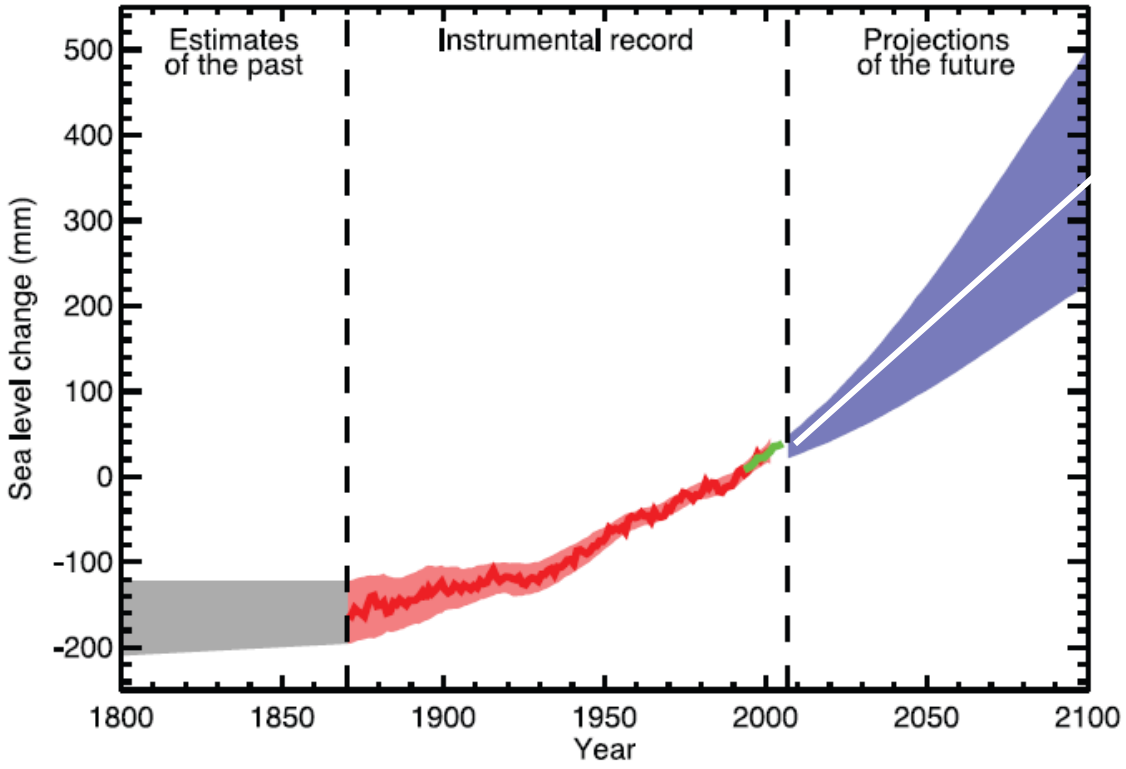
30 cm = 1 foot

This projection has over half the sea level rise as because of warming (expansion) of the ocean water

i.e. only 10-25 cm would be from melting ice input by glacial and ice cap ice.

IPCC, 2007

IPCC 2007 Projection



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30 cm = 1 foot

White line in projection is a continuation of currently observed rate of rise (green line).

In other words, the 2007 IPCC graphical projection shows little increase in rate of global sea level rise through this century!

IPCC, 2007

IPCC 2007
but they added these paragraphs -

"Thermal expansion is projected to contribute more than half of the average rise, but land ice will lose mass increasingly rapidly as the century progresses.

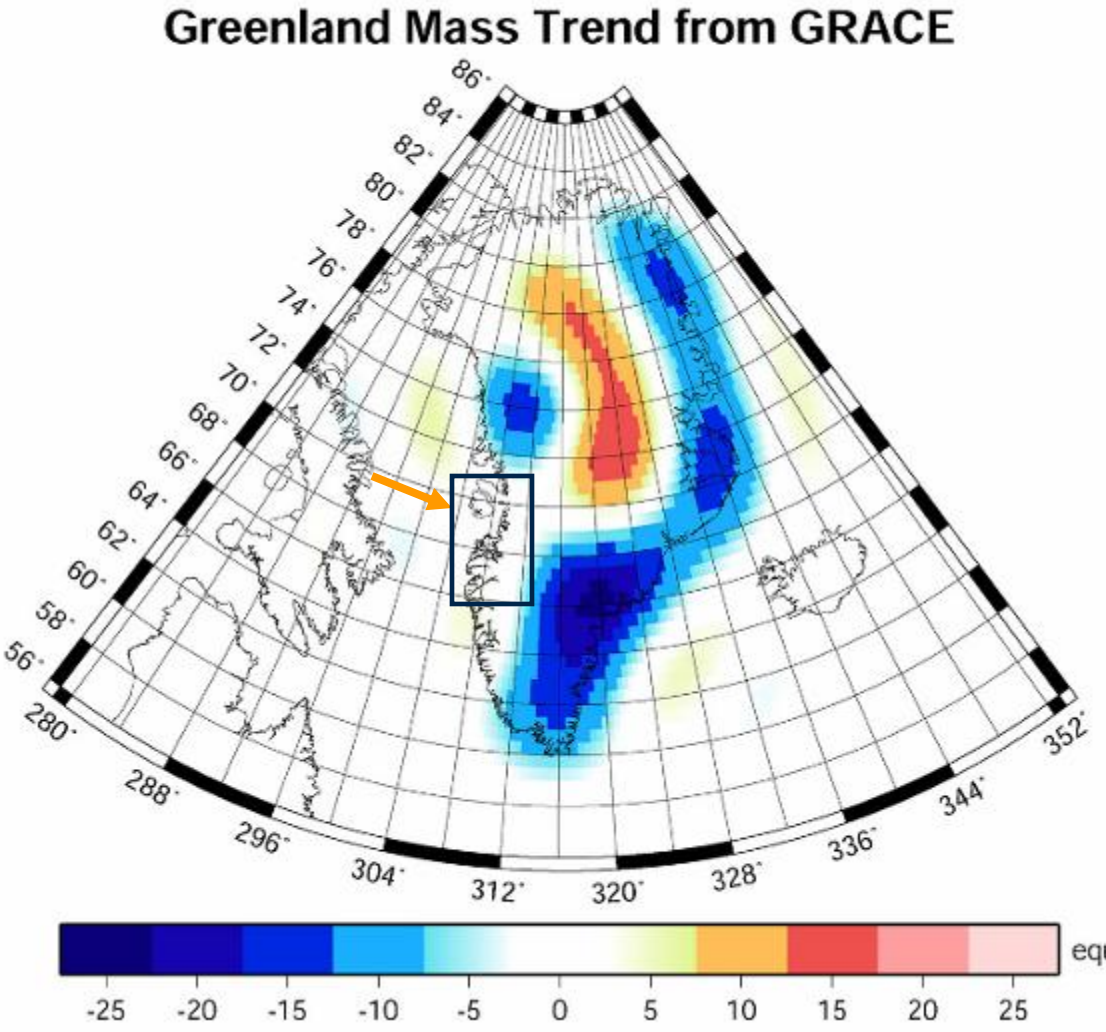
"An important uncertainty relates to whether discharge of ice from the ice sheets will continue to increase as a consequence of accelerated ice flow, as has been observed in recent years.

"This would add to the amount of sea level rise, but quantitative projections of how much it would add cannot be made with confidence, owing to limited understanding of the relevant processes."

The Answers to Florida's future lie in the Arctic

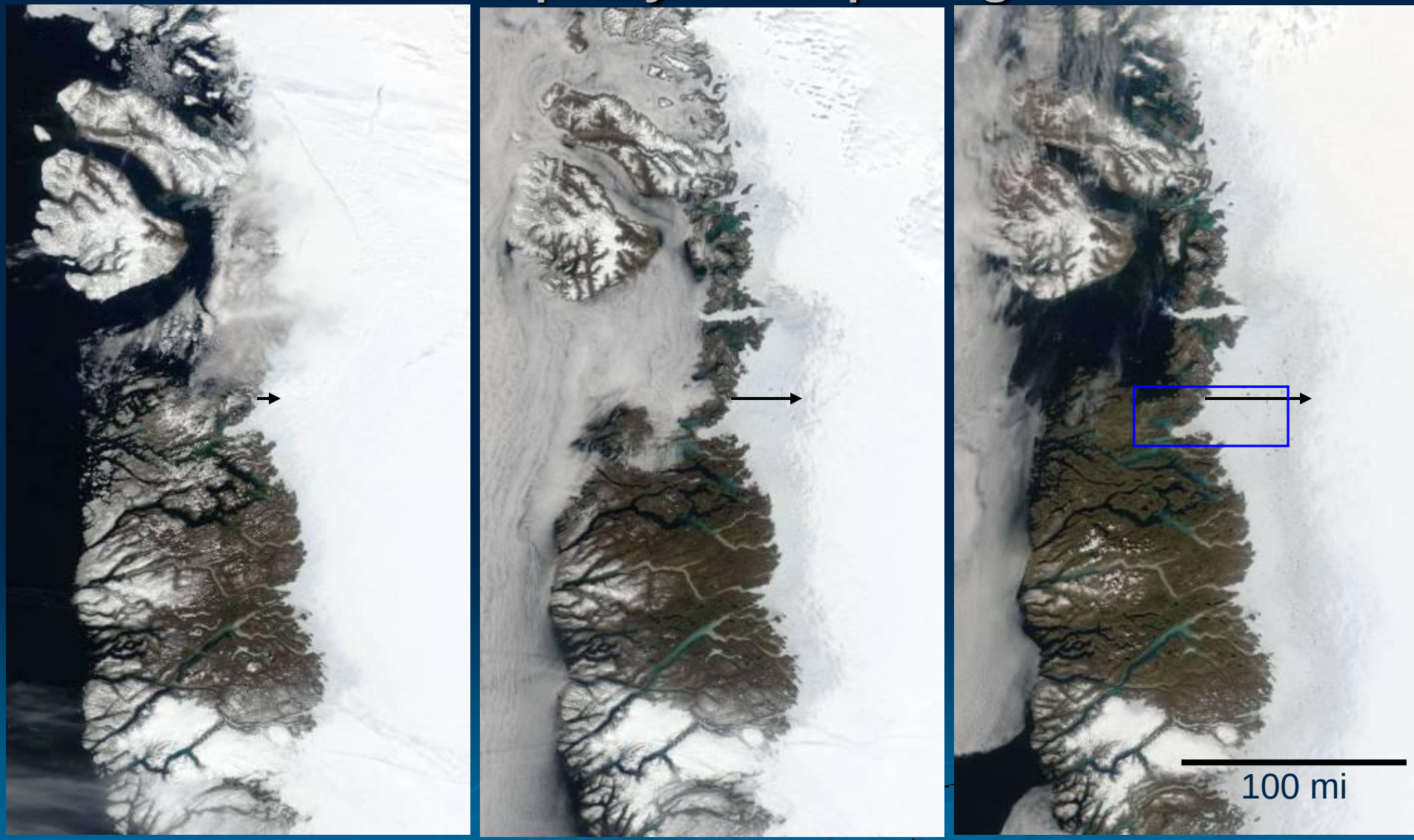
Since 2000,
the Greenland Ice Sheet
and the Arctic Ocean pack ice
have been rapidly falling apart.

Change in mass 2003-2005

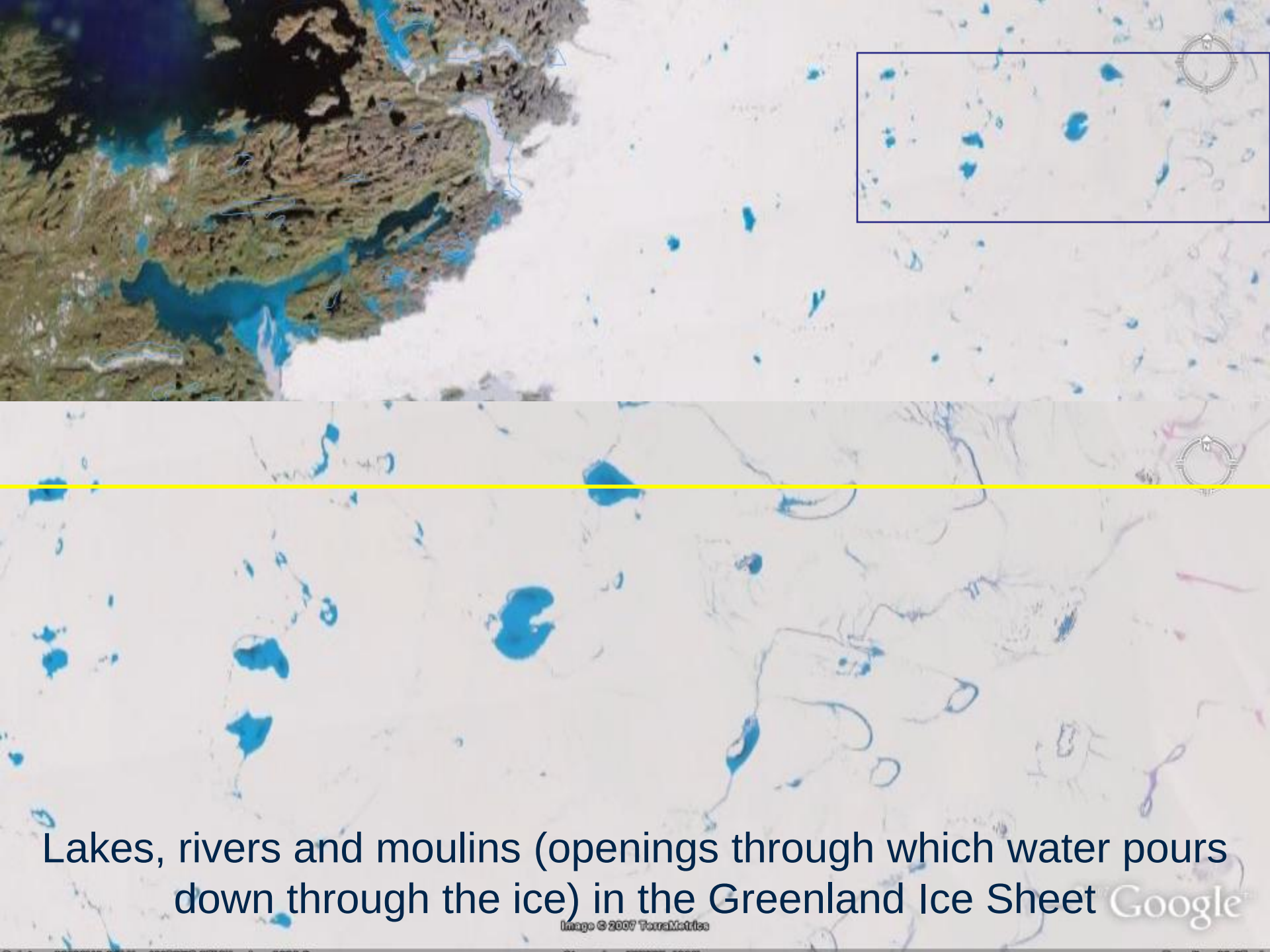


Melt zone is expanding northwards and to higher elevations

The margin of the Greenland ice sheet is rapidly collapsing



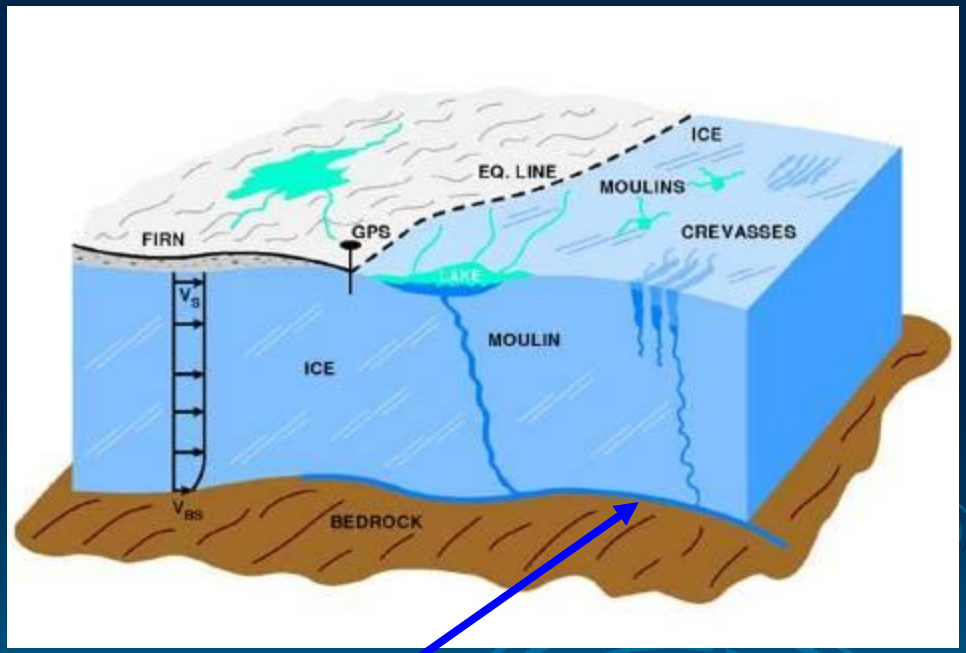
2001 2002 2003



Lakes, rivers and moulins (openings through which water pours down through the ice) in the Greenland Ice Sheet

MOULINS

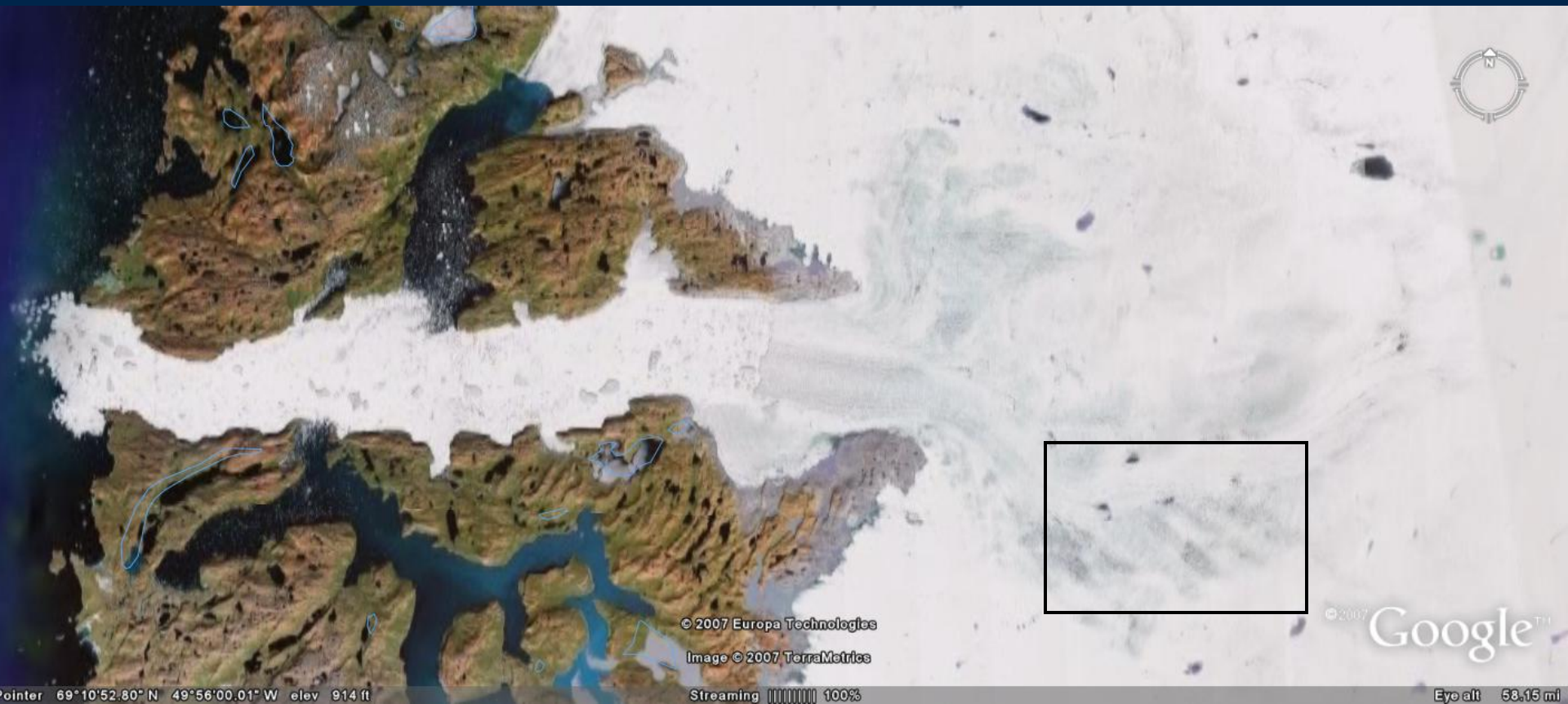
Like karst in limestones



Water lubricates base of ice sheet

- Thousands of moulins 10-15 meters across have opened up all over.
- melt water is pouring through to the bottom of the glacier, creating a lake 500 meters deep causing the glacier "to float on land."
- These melt-water rivers are lubricating the glacier, like applying oil to a surface and causing it to slide into the sea. It is causing a massive acceleration which could be catastrophic.

(Dr. Robert Corell, Chair Arctic Climate Impact Assessment, Sept 8, 2007)



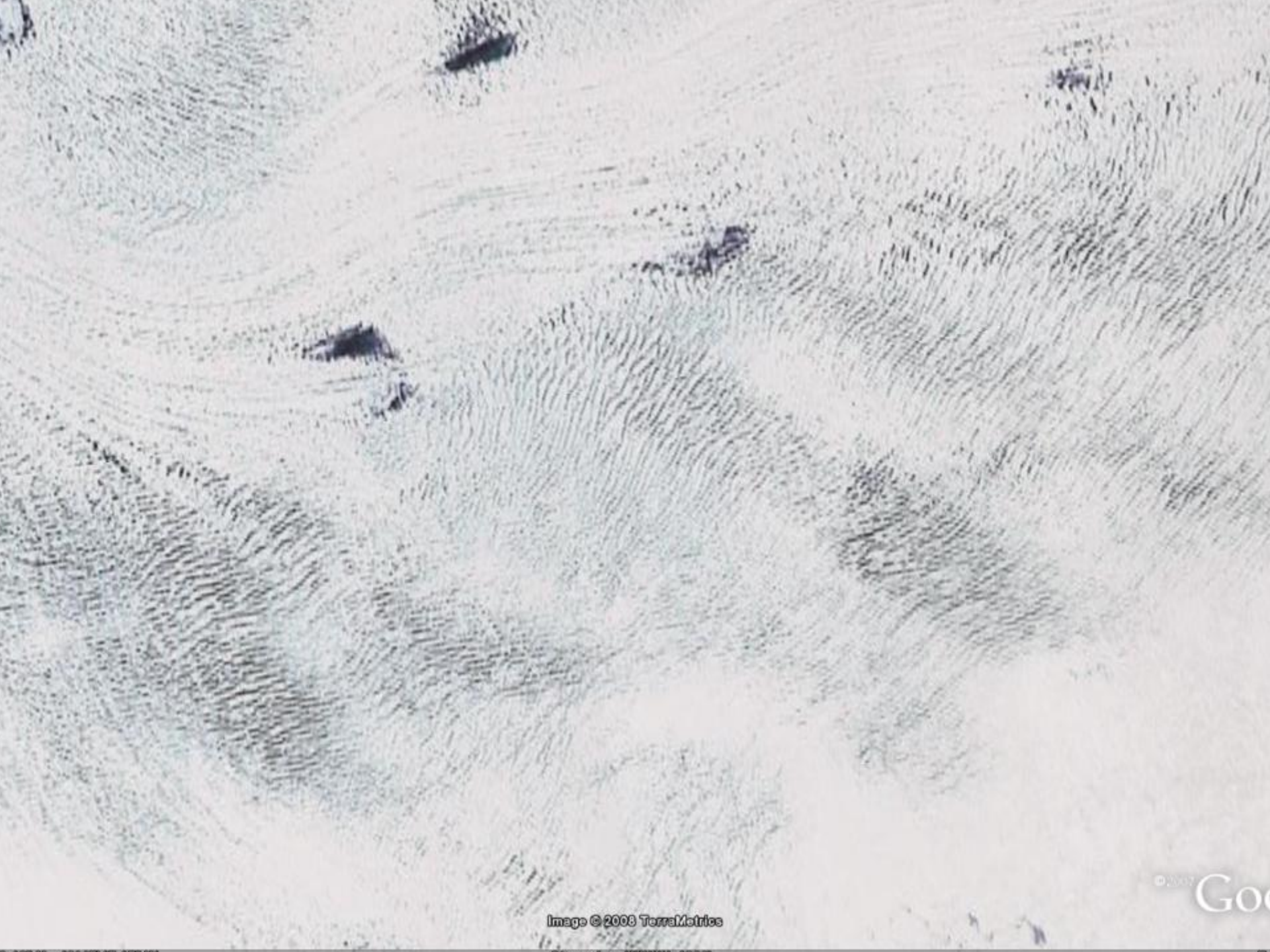


Image © 2008 TerraMetrics

- The Jacobshavn Isbreen (5 km wide and 1.5 km deep) is now moving at 15km a year into the sea, although in surges it moves even faster. 'One surge moved 5 km in 90 minutes - an extraordinary event. It's exuding like toothpaste.'

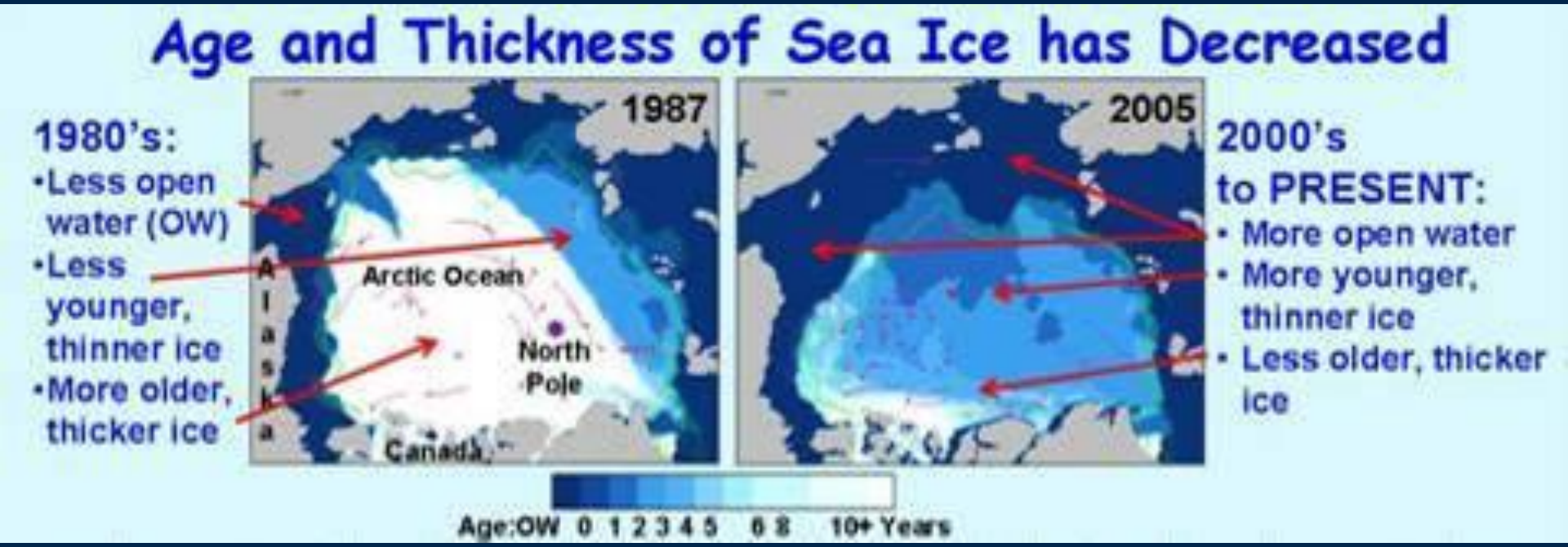
(Dr. Robert Corell, Chair Arctic Climate Impact Assessment, Sept 8, 2007)

Jacobshavn Isbreen I in Ilulissat, Vestgrønland (Greenland); Photograph by Dirk Jenrich

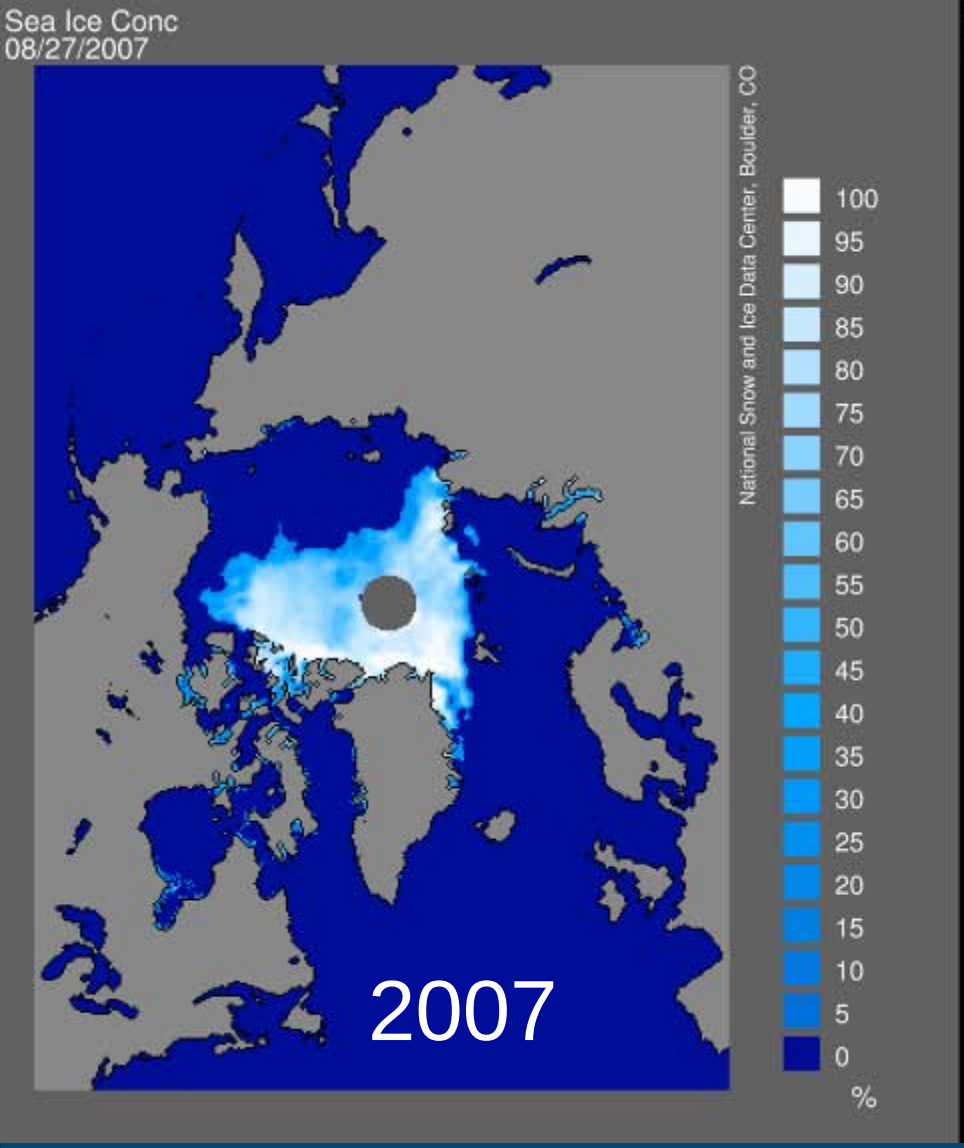
- "Five years ago we made models predicting how much ice would melt and when. "Five years later we are already at the levels predicted for 2040, in a year's time we'll be at 2050."

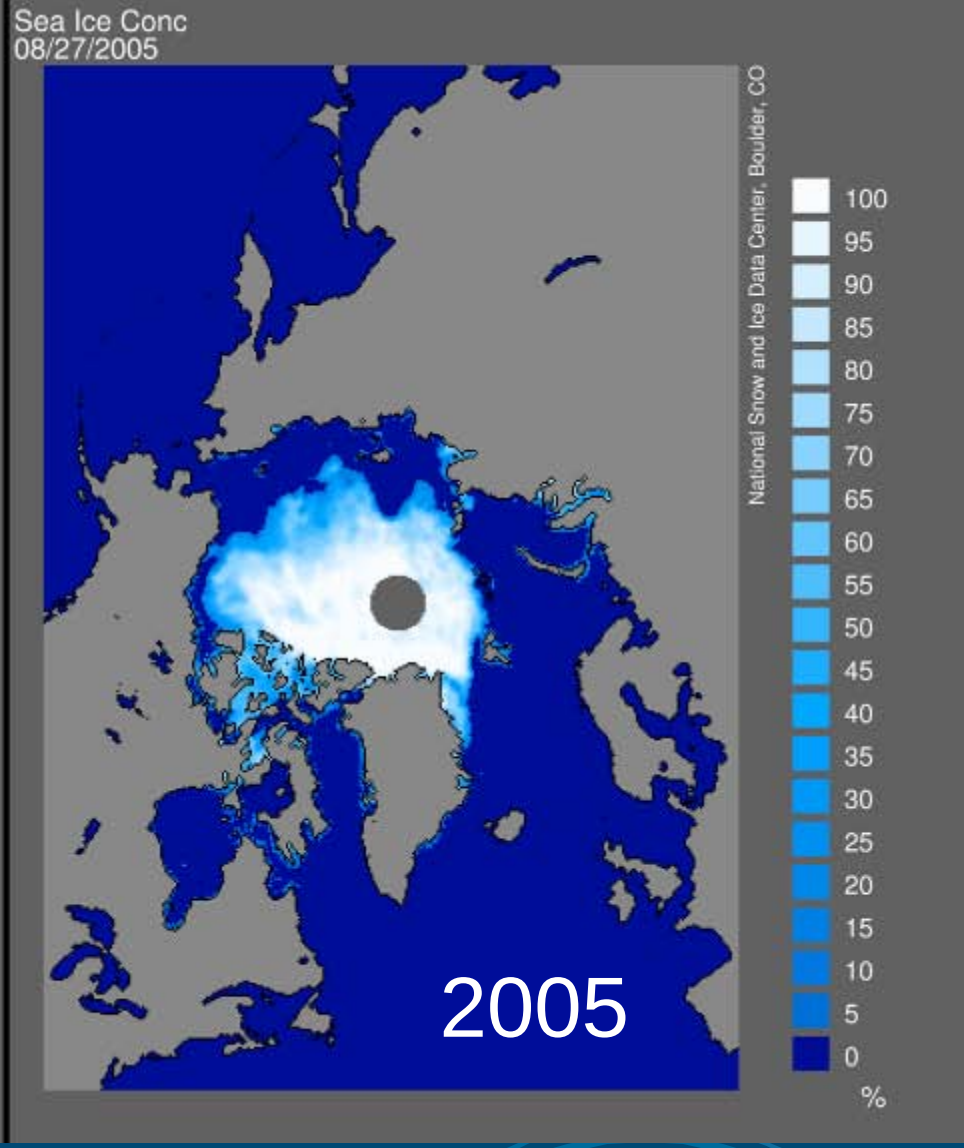
(Veli Albert Kallio, Finnish polar/ice scientist, September 8, 2007)

Arctic Pack Ice Cover



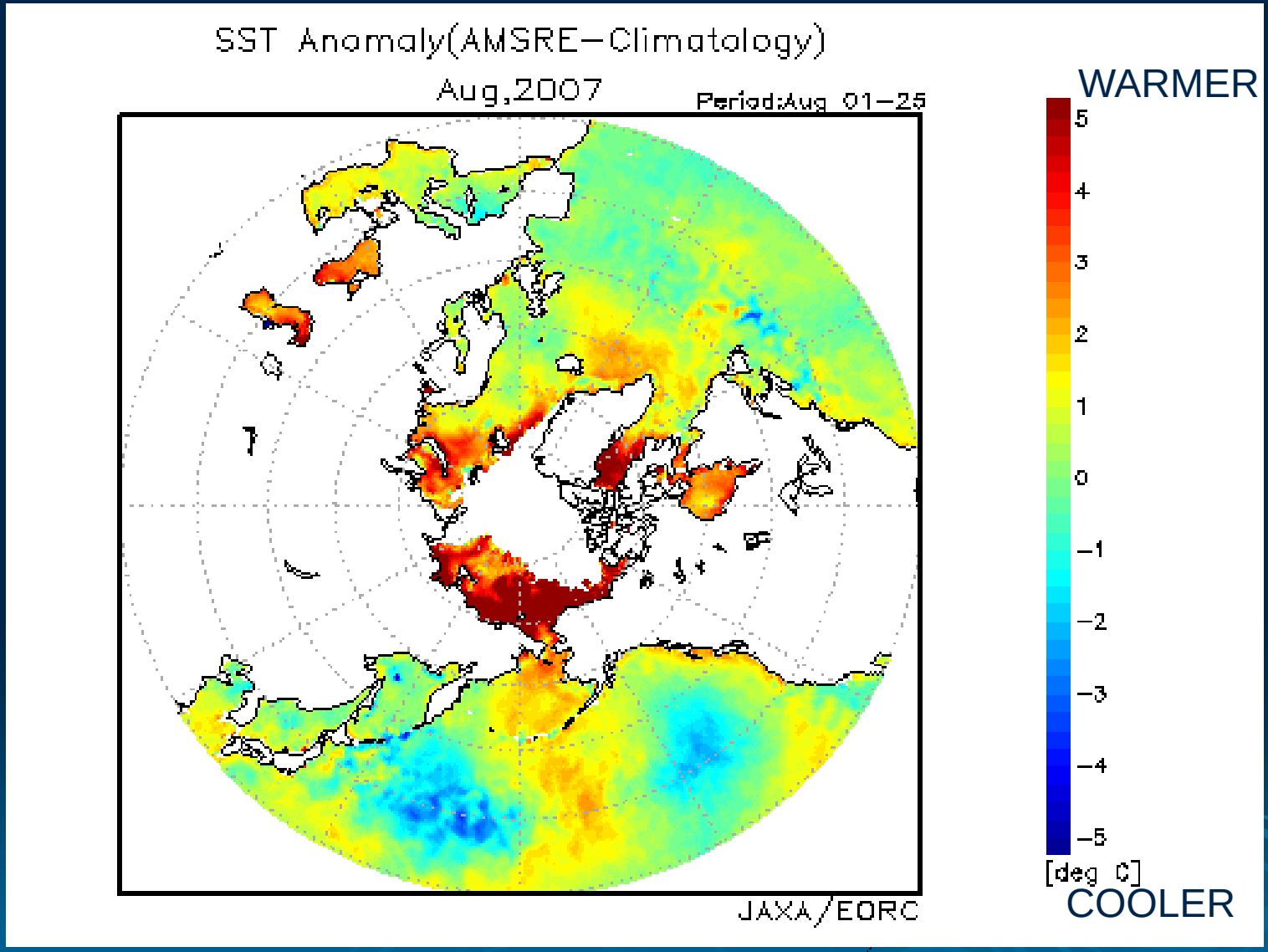
The 'permanent' Arctic pack ice is the refrigerator for the north. Its loss will catastrophically change Arctic ocean and land temperatures – and result in massive permafrost loss and catastrophic methane and carbon dioxide release.





This year the floating Arctic pack ice covered 33% less area than the previous record low in 2005. It is so thin and broken, it could easily just float out into the Atlantic.

Sea Surface Temperature Anomaly



Earth Observation Research Center, Japan Aerospace Exploration Agency
JAXA EORC

North Pole web cam – August 25, 2007

Ice reflects nearly all incoming solar radiation back into the air and space. Open water absorbs over 90% of incoming solar radiation

Reinforcing feedbacks in the Arctic and Greenland make future rapid warming inevitable and unstoppable.

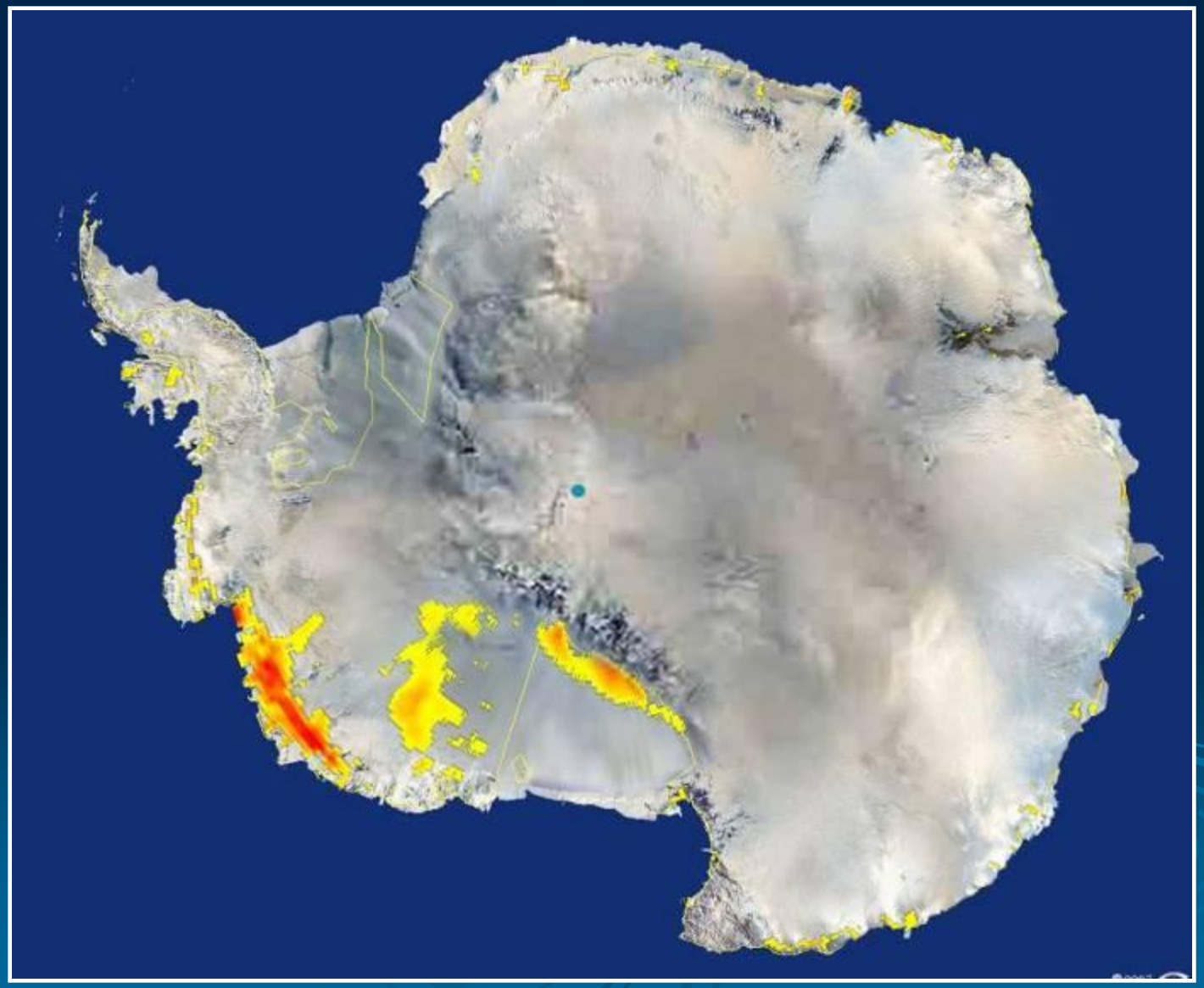
Greenland

1. Surface melt areas adsorb more heat.
2. Melt water lubricates base of ice sheet
3. Rapid loss to ocean
4. Lowering of ice sheet elevation
5. Further warming and destabilization.

Arctic Ocean

1. Persistent warming from atmosphere.
2. More open water
3. More heat adsorption
4. More melting
5. Warming of adjacent tundra and northern Greenland

Scientists are just now recognizing that Antarctica is also rapidly melting, and has been for some time. This is because of increased wind shear which has increased upwelling and melting under the ice shelves

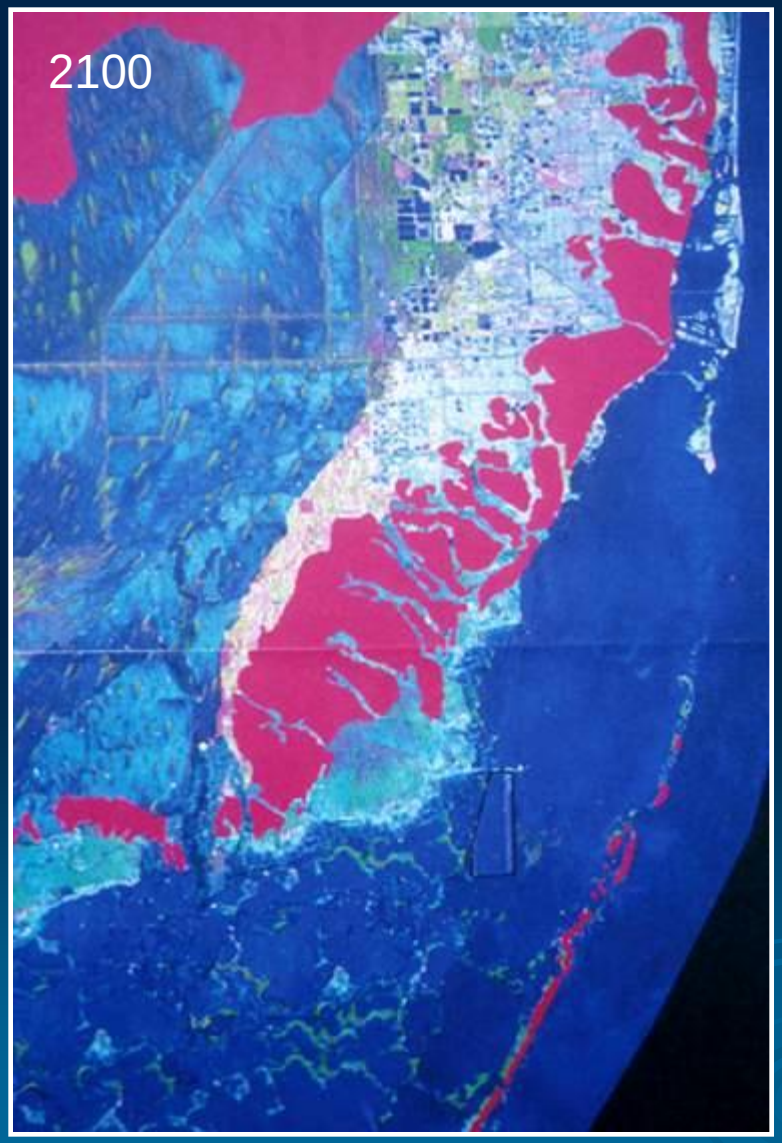


Scientists on the Miami-Dade Climate Change Task Force:

- "With what is happening in the Arctic and Greenland, [there will be] a likely sea level rise of **at least** 1.5 feet in the coming 50 years and a total of **at least** 3-5 feet by the end of the century, possibly significantly more. Spring high tides would be at +7 to +9 feet.
- "This does not take into account the possibility of a catastrophically rapid melt of land-bound ice from Greenland, and it makes no assumptions about Antarctica."
- "The projected rises will just be the beginning because of further significant releases from Greenland and possibly Antarctica."

(September 20, 2007)

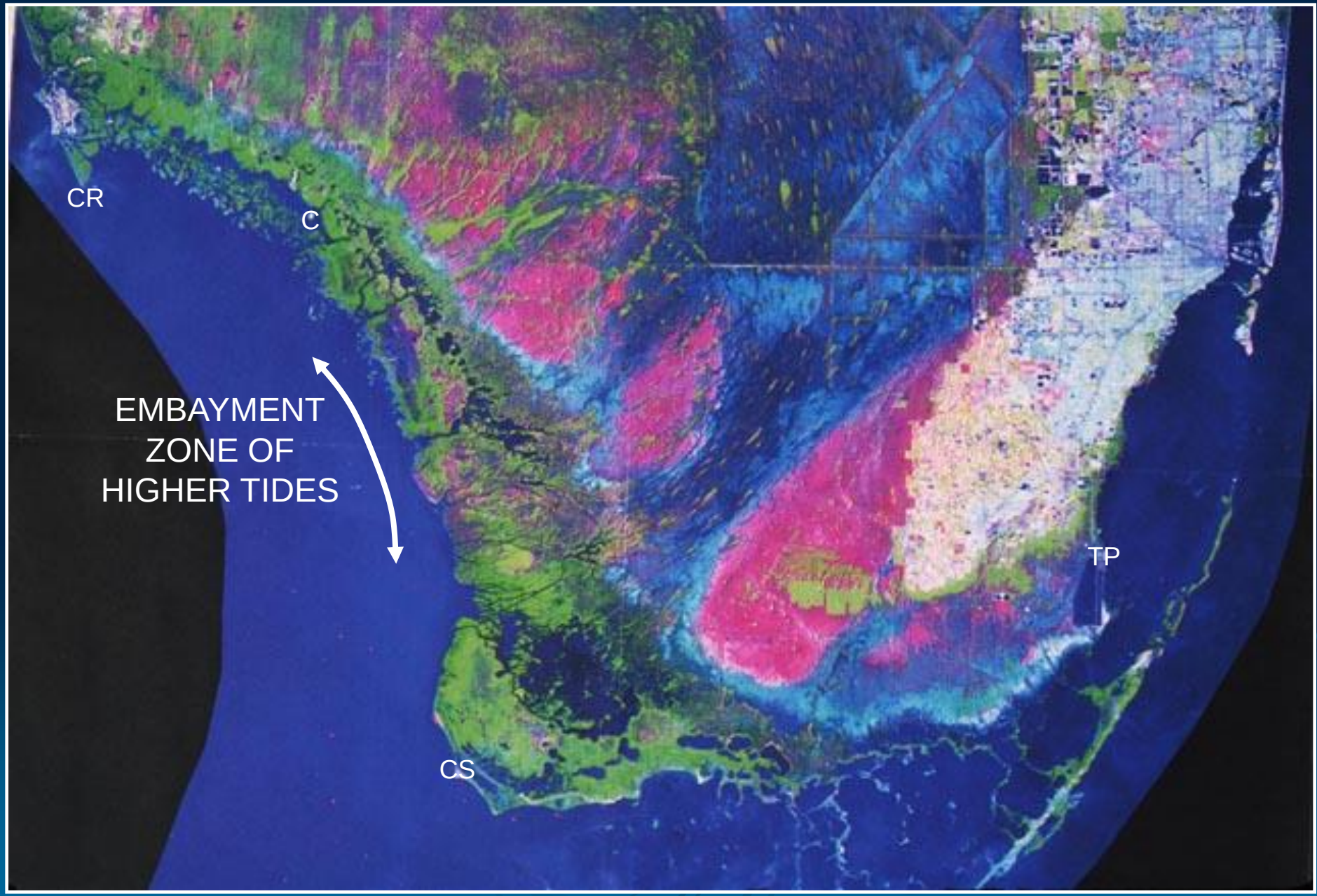
Red is areas with limestone more than 5’ above ‘sea level’ (mean sea level, NGVD 1929).



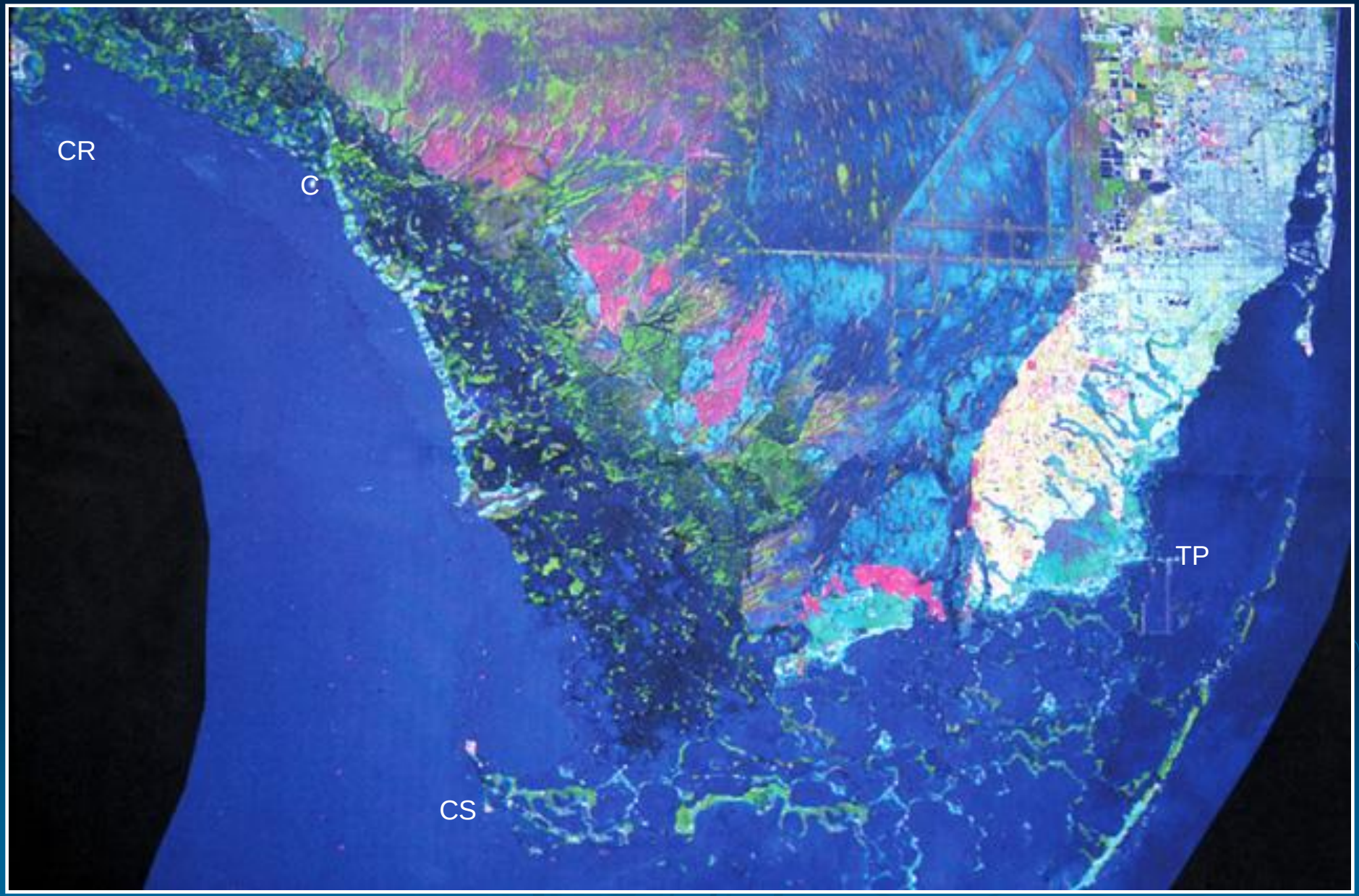
Today, mean higher high water (MHHW) is about 2.5’ above 1929 mean sea level.

With a 2 ft rise, MHHW will be about 4.5’ above 1929 mean sea level – with higher tidies and storm surges on top of that .

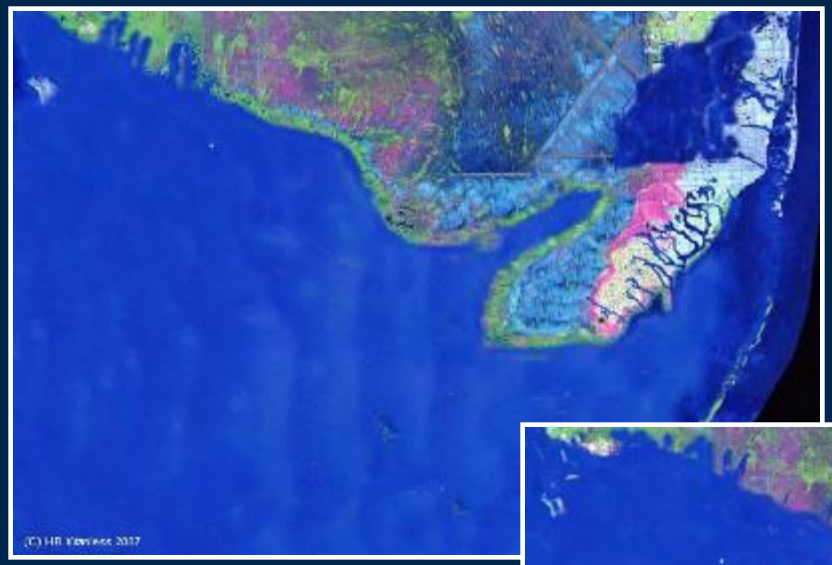
South Florida 1995



+2 foot rise (mhhw = +4.5’ above 1929 MSL) **South Florida 2100**

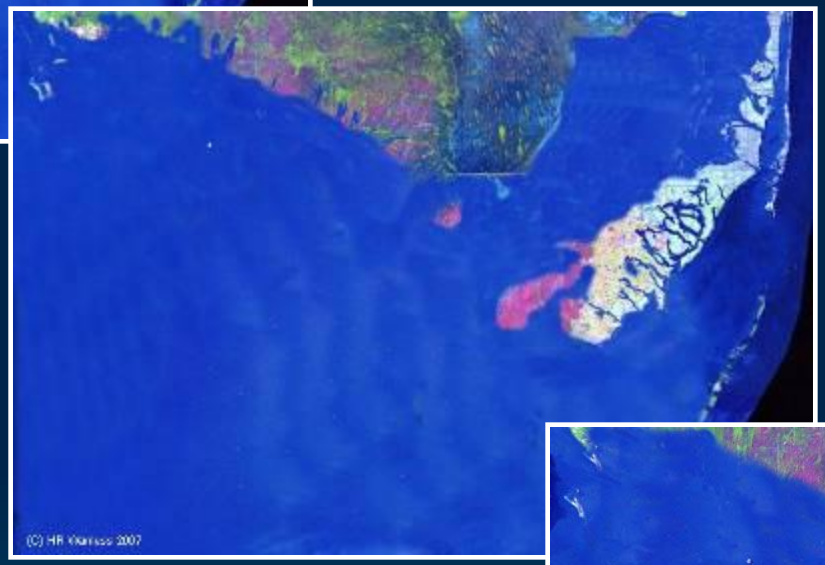


South Florida 2100



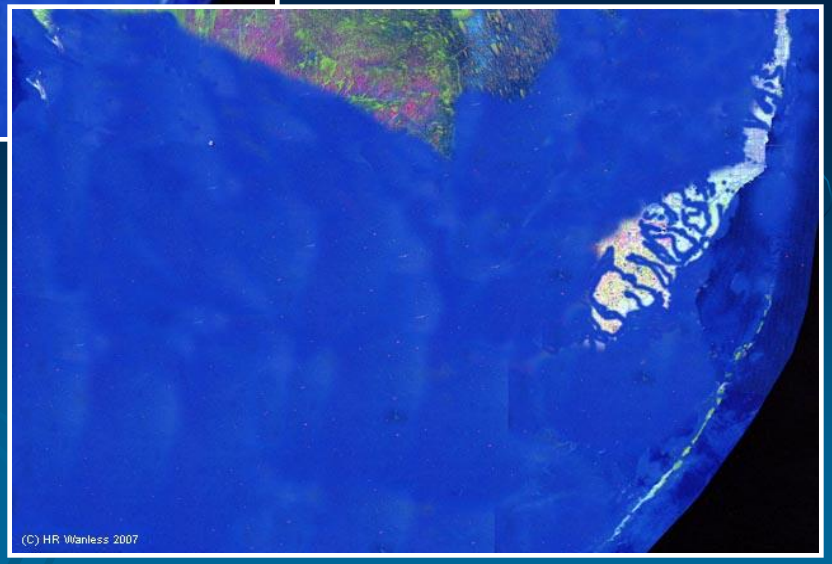
+4 foot rise

(mhhw = +6.5 feet above 1929 MSL)



+5 foot rise

(mhhw = +7.5 feet)



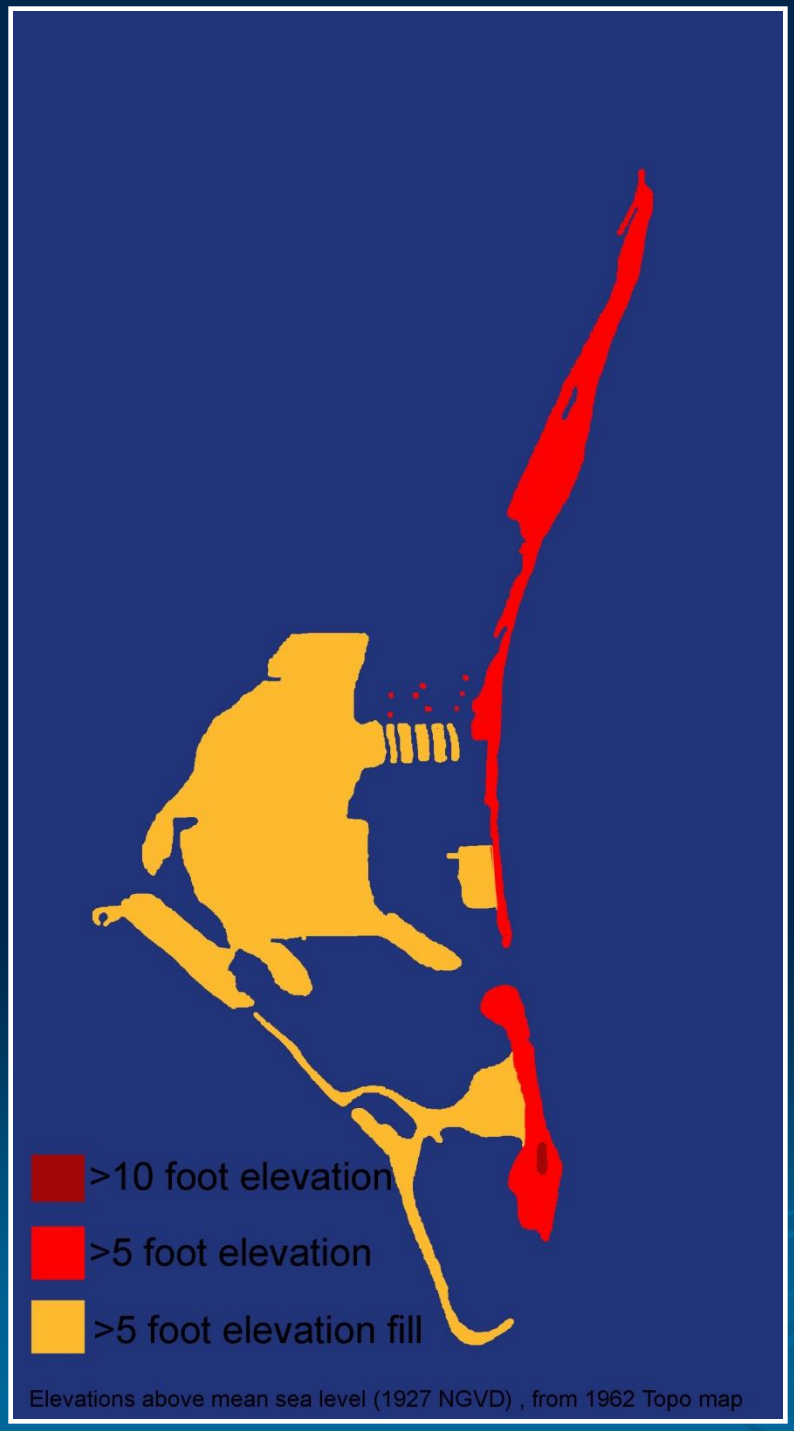
+6 foot rise

(mhhw = +8.5 feet)

Areas > 5 feet above mean sea level

Key Biscayne – Potentially emergent areas at MHHW with a +2.5 foot sea level rise

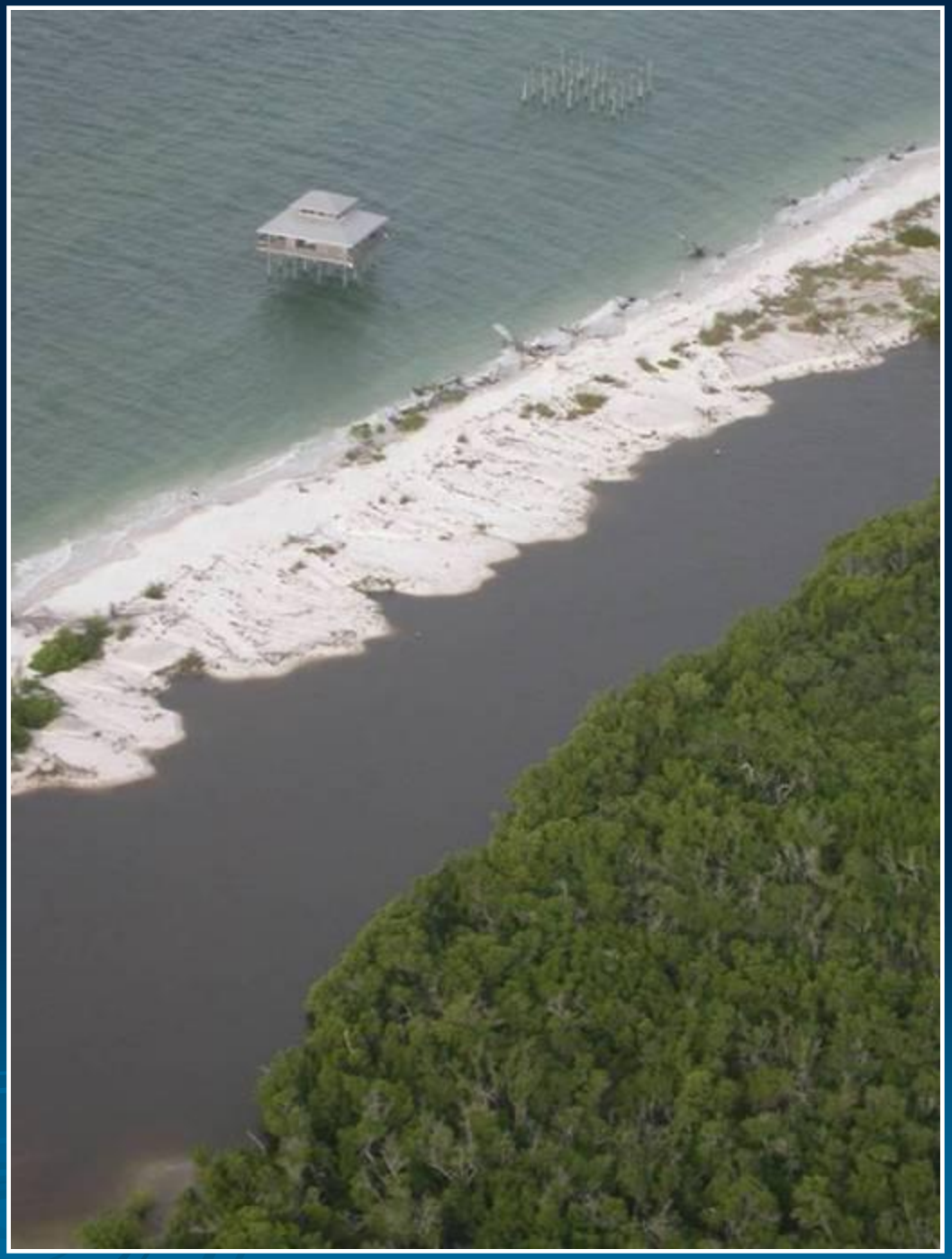
Elevations based on 1962 USGS topographic map



With a 4-5 foot sea level rise, will actually look more like this

The problem is that sandy barrier islands will try to move landward –

or if the rise is too fast, it will just be over ridden and abandoned.



Cape Romano, November 18, 2003

Science Committee Initial Recommendations

Recommendation A.1:

- The CCATF Science Committee's report, *Statement on Sea Level in the Coming Century,* is provided under Appendix I. The County should use the Science Committee's *Statement on Sea Level in the Coming Century* to guide future climate change mitigation and adaptation policy.

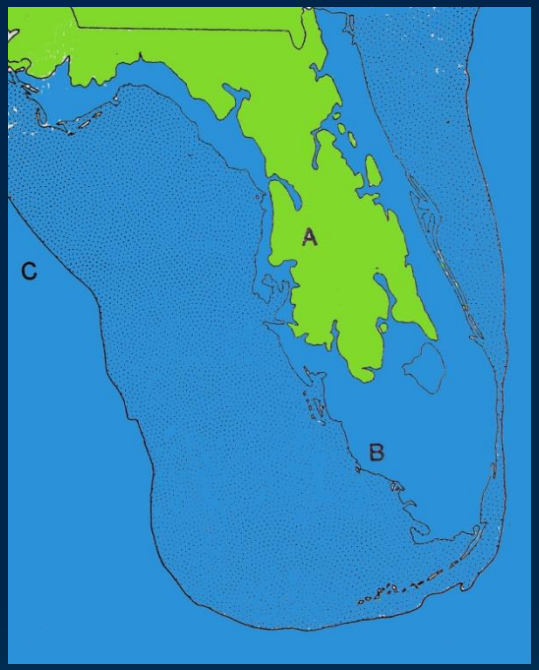
Science Committee Initial Recommendations

Recommendation A.2:

- The County should commission detailed maps for all of Miami-Dade County created from calibrated LIDAR surveys (or other elevation survey technology that employs best known practices).
- These maps will show mean high, high water (MHHW) levels for 1- foot through 6- foot rises in sea level. (MHHW level is the spring high tide level, which occurs every 14 days around full moon and new moon.)
- The maps will allow identification of which areas will become flooded in association with different sea levels and will provide a basis for assessing risk to the county's development and infrastructure.

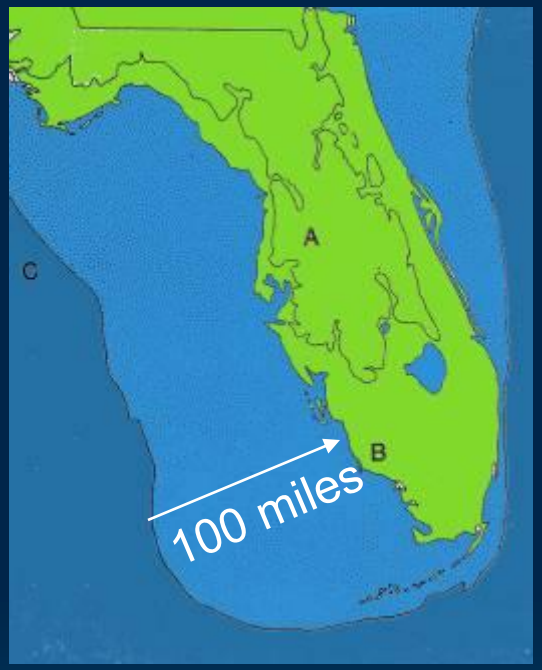
FLORIDA THROUGH TIME

Sea level has dramatically shifted in the past and can easily and quickly do so in the future



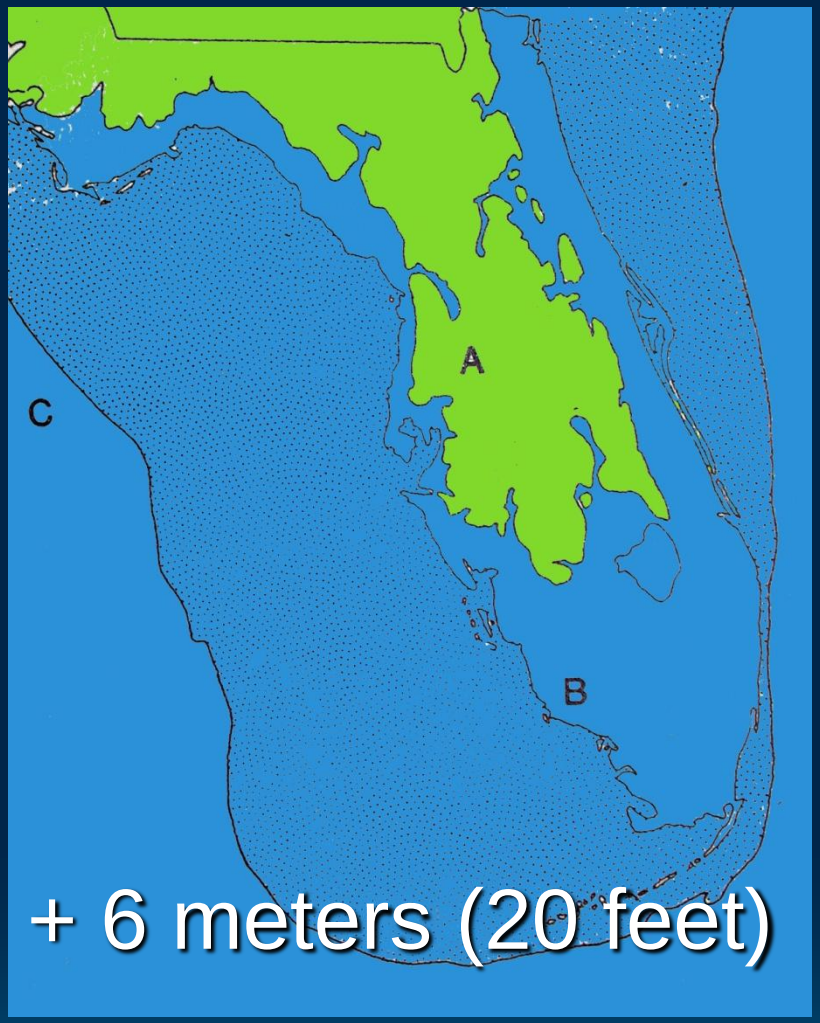
120,000 years ago
+ 6 meters (20’)

18,000 years ago
- 120 meters (420’)



Today

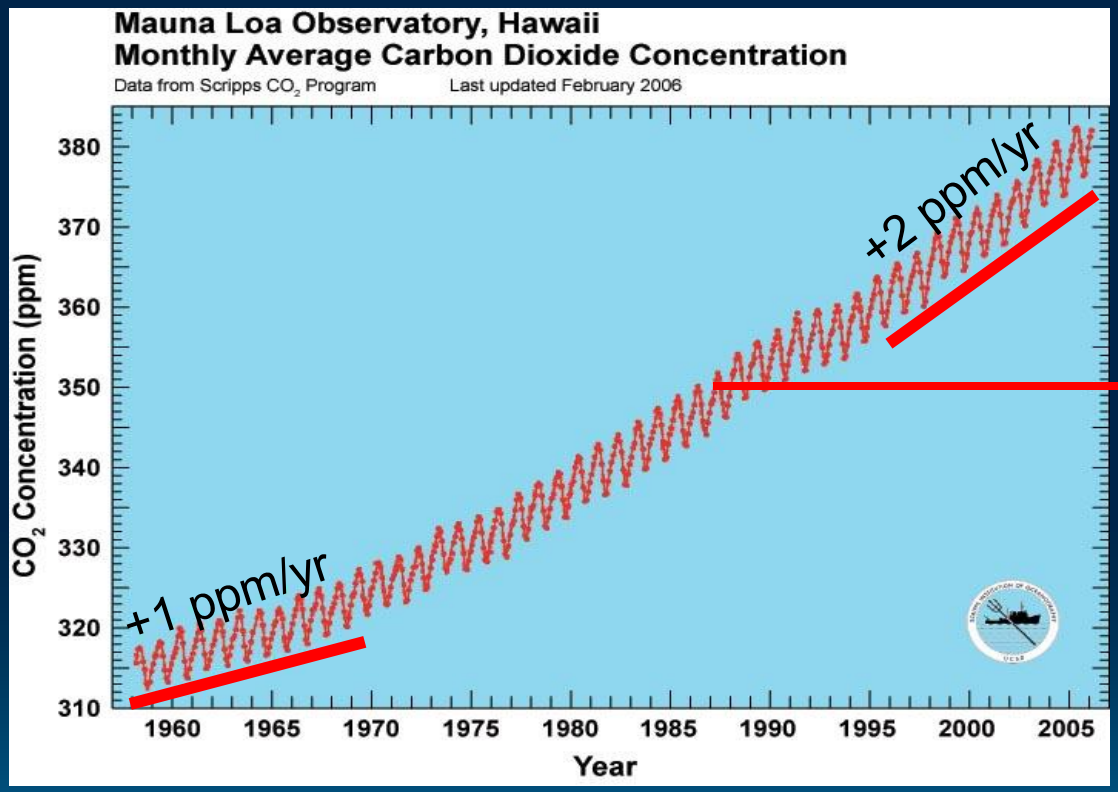
~ ½ from Greenland
~ ½ from Antarctica



If we do not stop human-induced warming, this is our likely future by 2200 or before.

What can we do?

- Most critically, we need to get off the CO2-producing addiction.



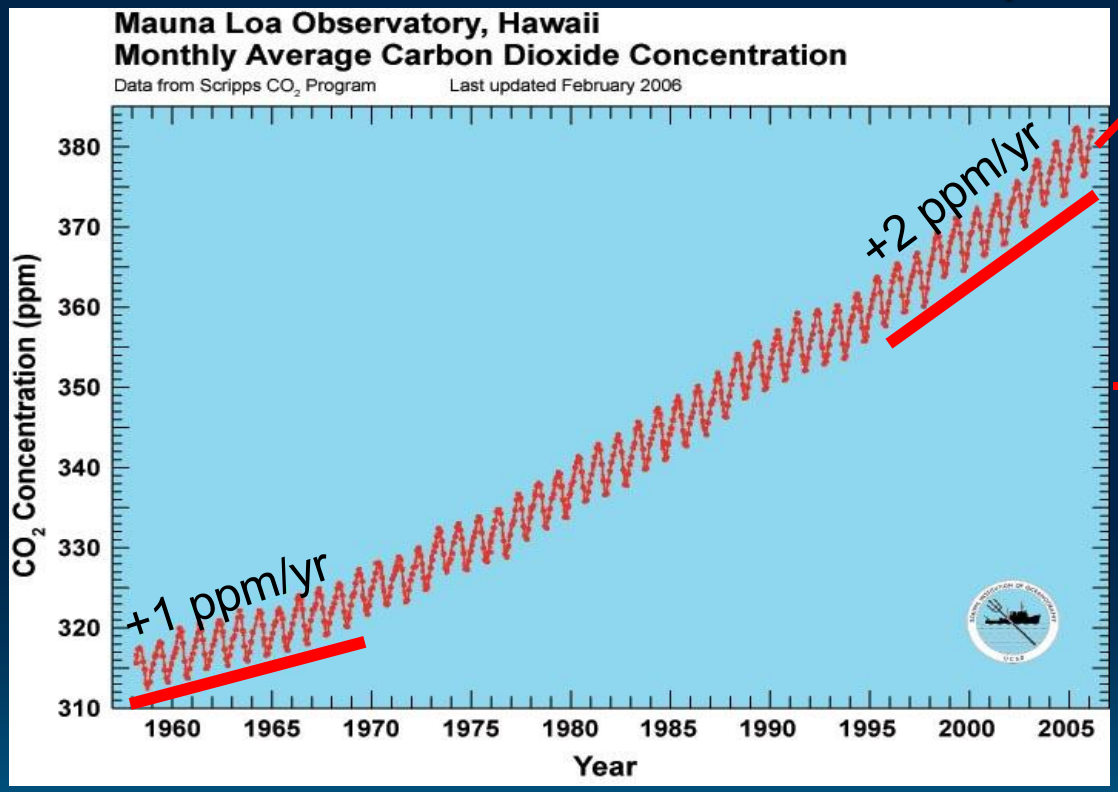
Presently 387 ppm and rising about 2.5 ppm / year

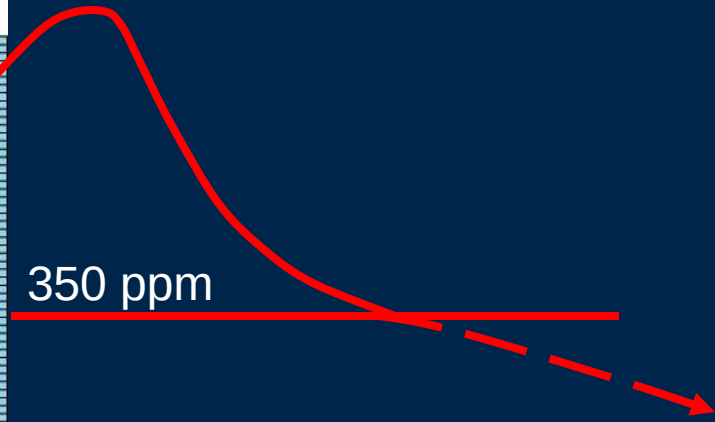
350 ppm

- Leading climatologist, Dr. James Hansen, says we quickly need to reduce atmospheric CO2 to 350 ppm.

We must stop warming.

- Lowering atmospheric CO2 would slow the heat imbalance between the atmosphere and the ocean.

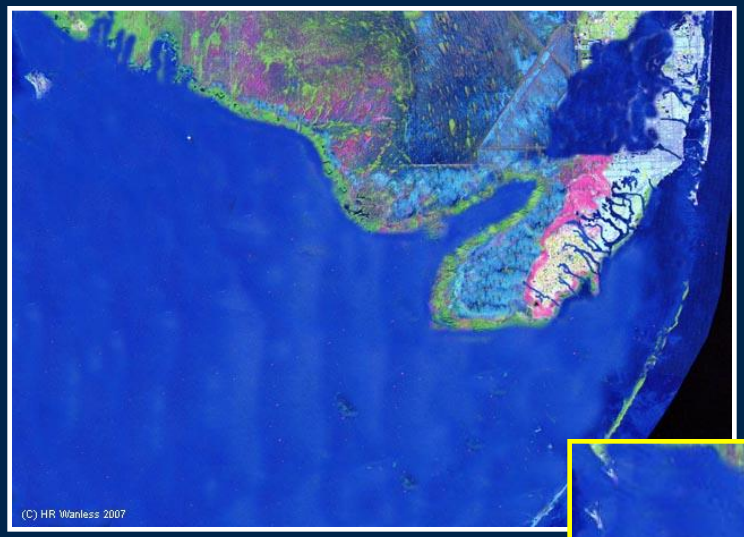




- This probably will not slow the first 3-5 feet of sea level rise, but will be a step for limiting a catastrophic greater rise.

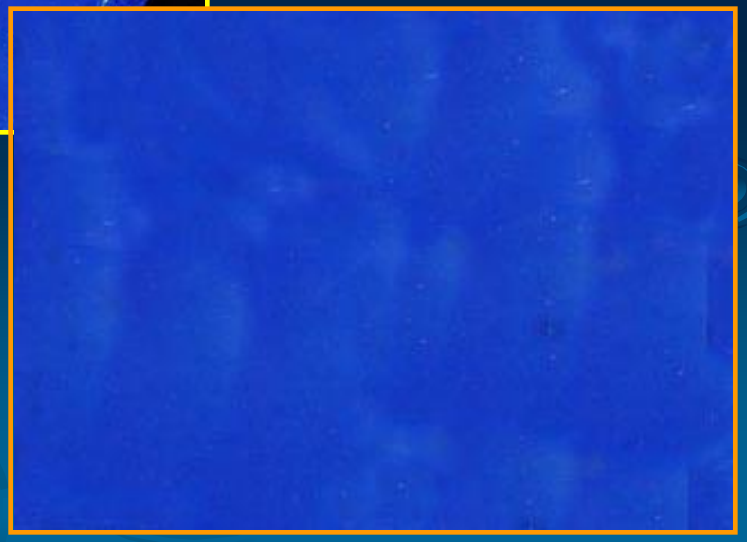
The United States is still the leading cause of global warming.

- We must take the lead in -
  - Drastically reducing our greenhouse gas and fine particulate soot production and release.
  - Rapid development and implementation of truly clean energy sources.
- Then, we can take the leadership that the world will follow.



•We may have to deal with the beginning several feet of the coming sea level rise.

If humanity quickly gets its act together, we can probably prevent this



If we do not, south Florida will most certainly look like this within a few centuries.

GOOD LUCK;

IT MUST BE DONE.

LOCALLY

GLOBALLY

URGENTLY

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